COLLIDER-ACCELERATOR DEPARTMENT
(C-AD)

ACCESS TRAINING

Radiation Safety
Conventional Safety
Access Control

INFORMATION GUIDE

Includes Equivalency for Training Course: (<u>for access to areas at C-AD ONLY</u>):

- Oxygen Deficiency Hazard - Class 0 Areas

July 2006

C-AD ACCESS TRAINING

This course is required if you want unescorted access to Collider-Accelerator Department (C-AD) Primary Areas. These areas include (but are not limited to): W, X, and Y lines, the Collider Tunnel, the AGS Tunnel, the Booster Tunnel, LINAC to Booster (LtB) Line, Tandem to Booster (TtB) Line, Switchyard, Slow Extraction Beam (SEB) primary beam lines, Fast Extraction Beam (FEB) primary beam lines, U Line, V Line, AGS to RHIC (AtR) Transfer Line, Booster to NSRL primary beam line, or any of the target rooms. Primary Areas are typically posted Radiation or High Radiation Areas. Primary Areas are areas where beam travels and are to be considered lethal areas with beam on. With beam on, access is prohibited. The beam is intense enough to deliver a lethal dose in a single pulse. You are NEVER permitted to climb over or defeat barriers.

This course is also required for unescorted access to other (non-Primary) areas of the C-AD complex such as assembly, service and support buildings, areas of LINAC, Tandem or NSRL facilities, AGS Bldg 912, or other areas of the complex, both indoors and outdoors. This course may be required if you are conducting work anywhere at the C-AD complex. Be aware that work policies and practices at C-AD may be more restrictive than elsewhere at the Lab so you must always follow proper C-AD work planning procedures.

This course provides you with basic information about the primary area Access Control System and Particle Accelerator Safety System (PASS) at C-AD. The course covers physical design features and administrative controls that are used to prevent accidental radiation exposures.

Work control requirements at C-AD are also discussed in this course.

This course includes an approved equivalency for BNL's Oxygen Deficiency Hazard Class 0 Training (BNL # TQ-ODH).

A pre-requisite for this course is BNL's Radiation Worker Training. Please be aware that successful completion of this Access Training and Radiation Worker Training does not allow you to work in C-AD Contamination Areas. Additional Contamination Worker Training is required in these areas. Also, successful completion of this Access Training does not allow you to remove activated materials from posted areas without the assistance of a Radiological Control Technician (RCT).

In addition to ionizing radiation hazards, C-AD areas may contain hazards posed by:

- heavy objects
- mechanical equipment
- remotely operated equipment (personnel entanglement in mechanism)
- overhead cranes
- heights
- magnetic fields
- hot and cold surfaces
- steam
- high-voltage and high-current electrical systems
- noise hazards

- oxygen deficiency from release of helium, nitrogen, carbon dioxide, or sulfur hexafluoride
- radio-frequency (RF) radiation
- contamination and oxygen deficiency from smoke and fire
- slips, trips falls

We strive to maintain an excellent safety record in such a complex environment without undue inconvenience to the C-AD staff or others. We can assure the continuity of a good safety record only by having the active cooperation of each individual who has access to the C-AD complex. Each of you should familiarize yourselves with C-AD safety requirements, procedures, and the Local Emergency Plan which can be found in the C-AD Operations Procedures Manual (OPM), Chapter 3.

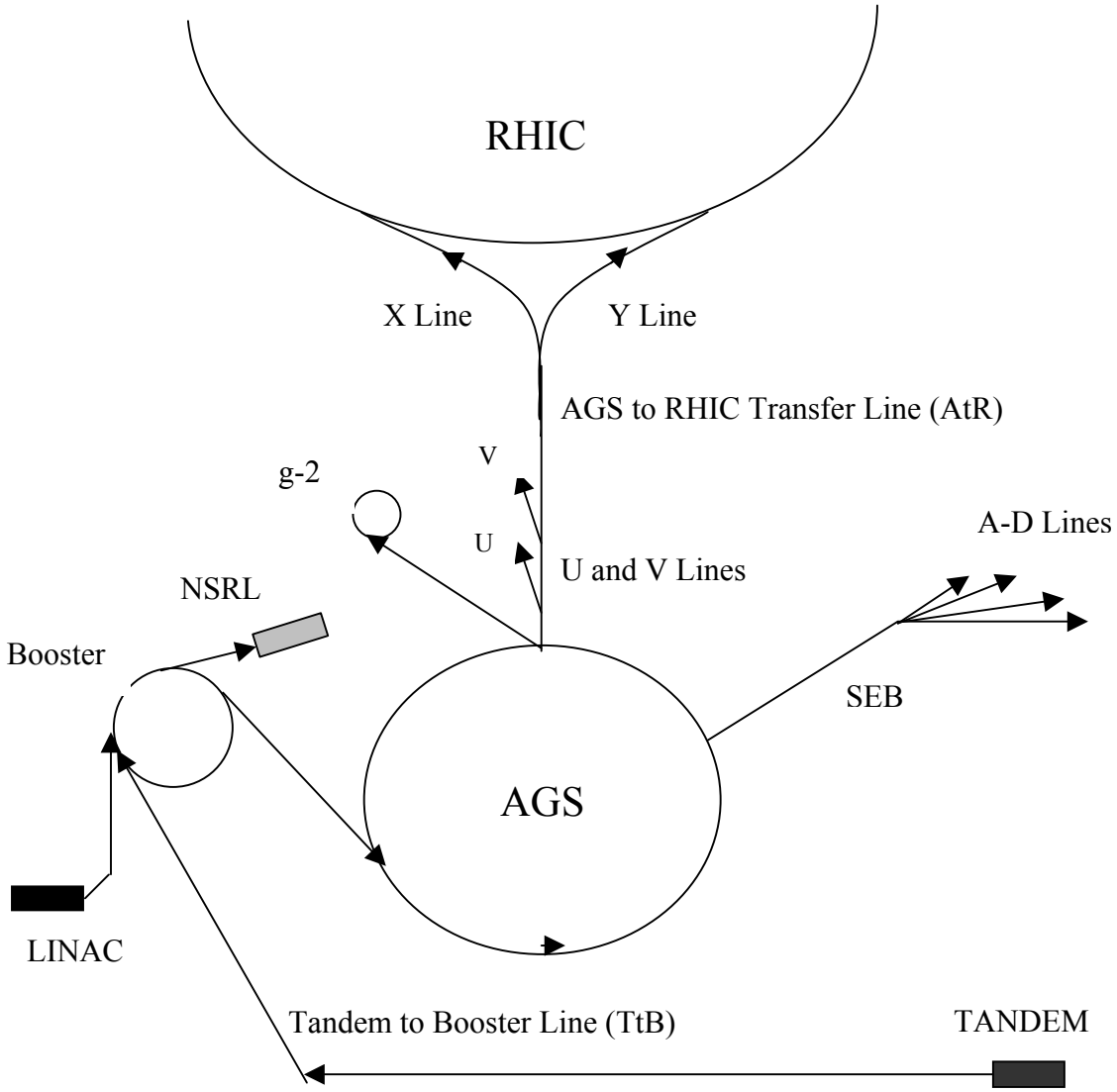
As a worker at the C-AD complex you will most likely require additional job specific training. This may include web-based or classroom training given by the BNL Training Office such as Electrical Safety, Lock-Out Tag-Out, Compressed Gas Safety, Machine Shop Safety, Cryogenic Safety, Fall Protection, Crane Operator, Rigging, Fork Lift Operator, ODH Class 1, Confined Space, or Atmospheric Testing. Additional training may also incude training given by C-AD supervisors such as LOTO OJT and training on C-AD OPM Procedures or Group Procedures. Some training is given by others at C-AD such as Confined Space Atmospheric Testing Practical, ODH Class 1 Practical and Electrical Safe Work Practices (for working "on-or-near" energized systems). Your supervisor should consult with the C-AD Training Manager to determine your training requirements.

It is your responsibility to maintain your training current. You are not allowed to perform work or operate in areas for which you are either untrained or for which your training has expired.

FACILITY DESCRIPTION

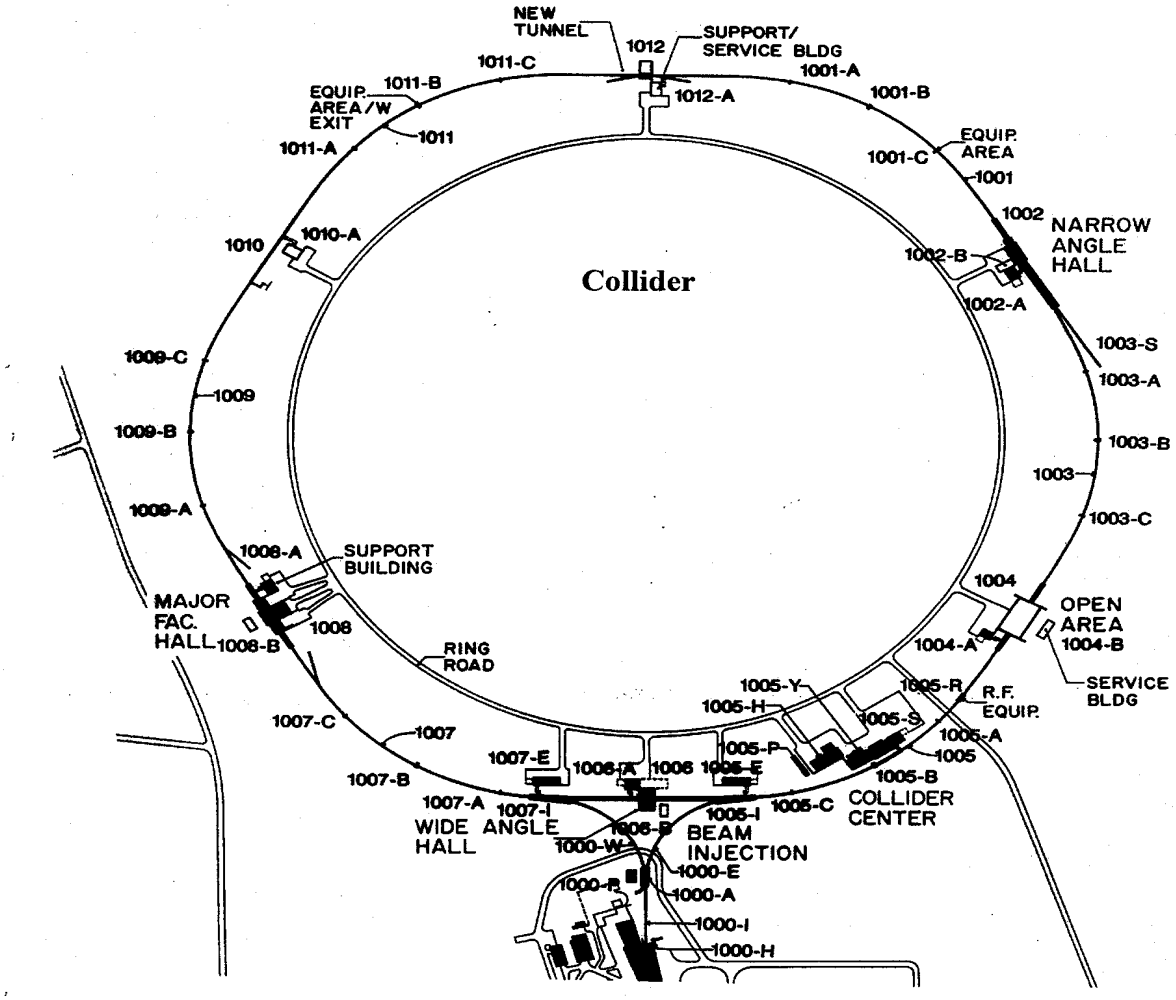
PRIMARY AREAS are areas where beam is fully enclosed. For proton running, this typically includes the LINAC, Booster, AGS, the switchyard and beam lines up to the proton target stations (target rooms or target caves). The switchyard, A, B, C and D beam lines form what is named the SEB (slow-extracted-beam) areas. Beam lines U and V form the FEB (fast-extracted-beam) areas. For heavy-ion running, primary areas typically include the Tandem, Tandem to Booster Line (TtB), AGS, AGS to RHIC (AtR) Transfer Line, X and Y lines, and the Collider tunnel. Primary areas are fully enclosed by shielding and/or have barriers. They are generally arranged as shielded areas with interlocked gates. The tube-like enclosures that directly surround the beam (the beam pipe) are also considered primary areas.

Below are views/sketches of some C-AD areas.

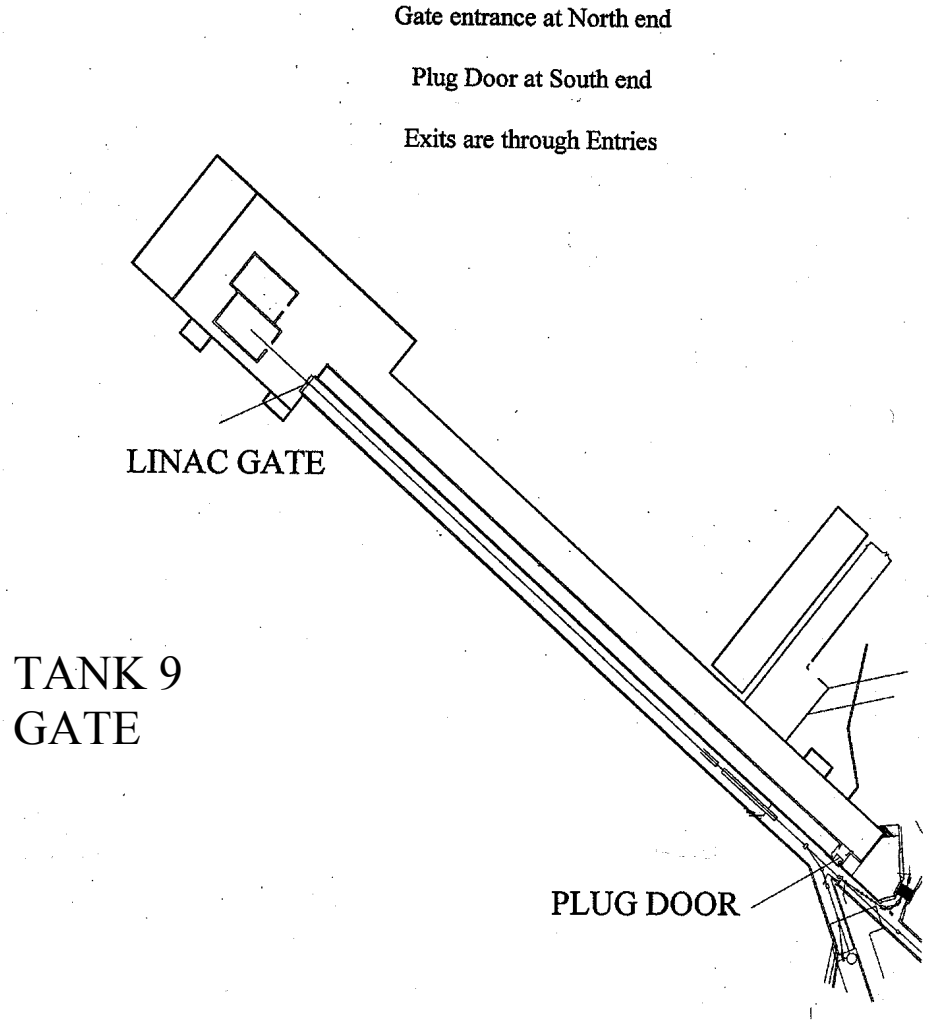

RHIC
X Line
Y Line
AGS to RHIC Transfer Line (AtR)
V
g-2
U
A-D Lines
U and V Lines
NSRL
Booster
SEB
AGS
LINAC
Tandem to Booster Line (TtB)
TANDEM

Relativistic Heavy Ion Collider (RHIC)

COLLIDER RING



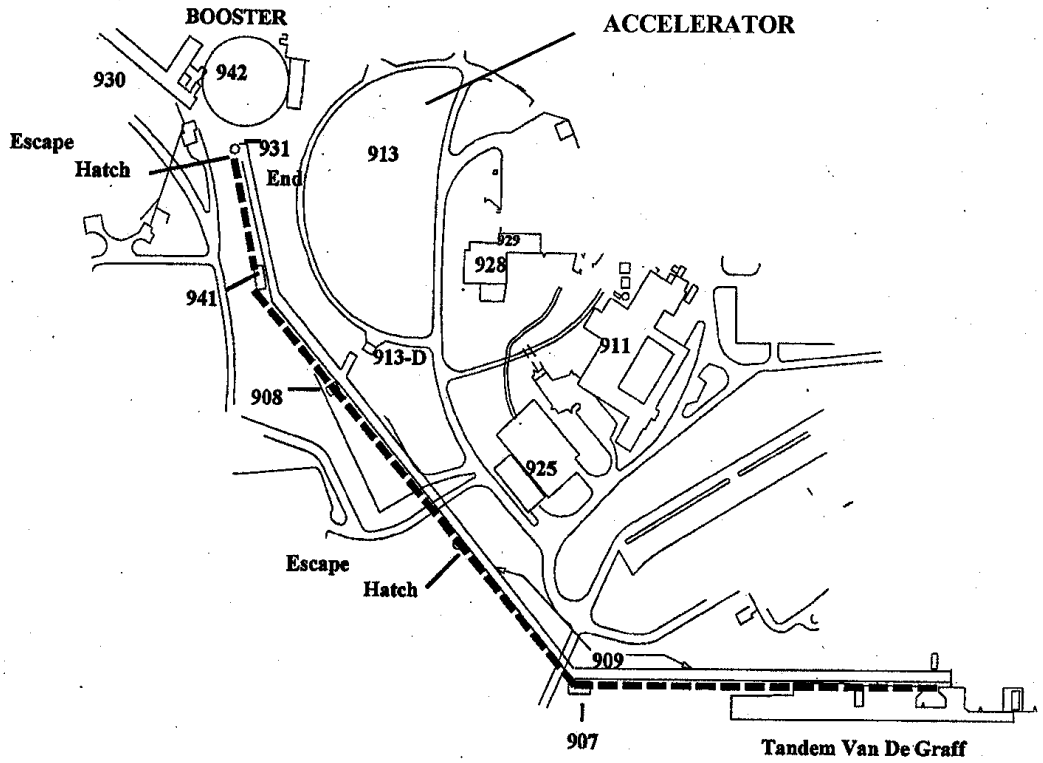
LINAC TUNNEL BUILDING 930 BASEMENT

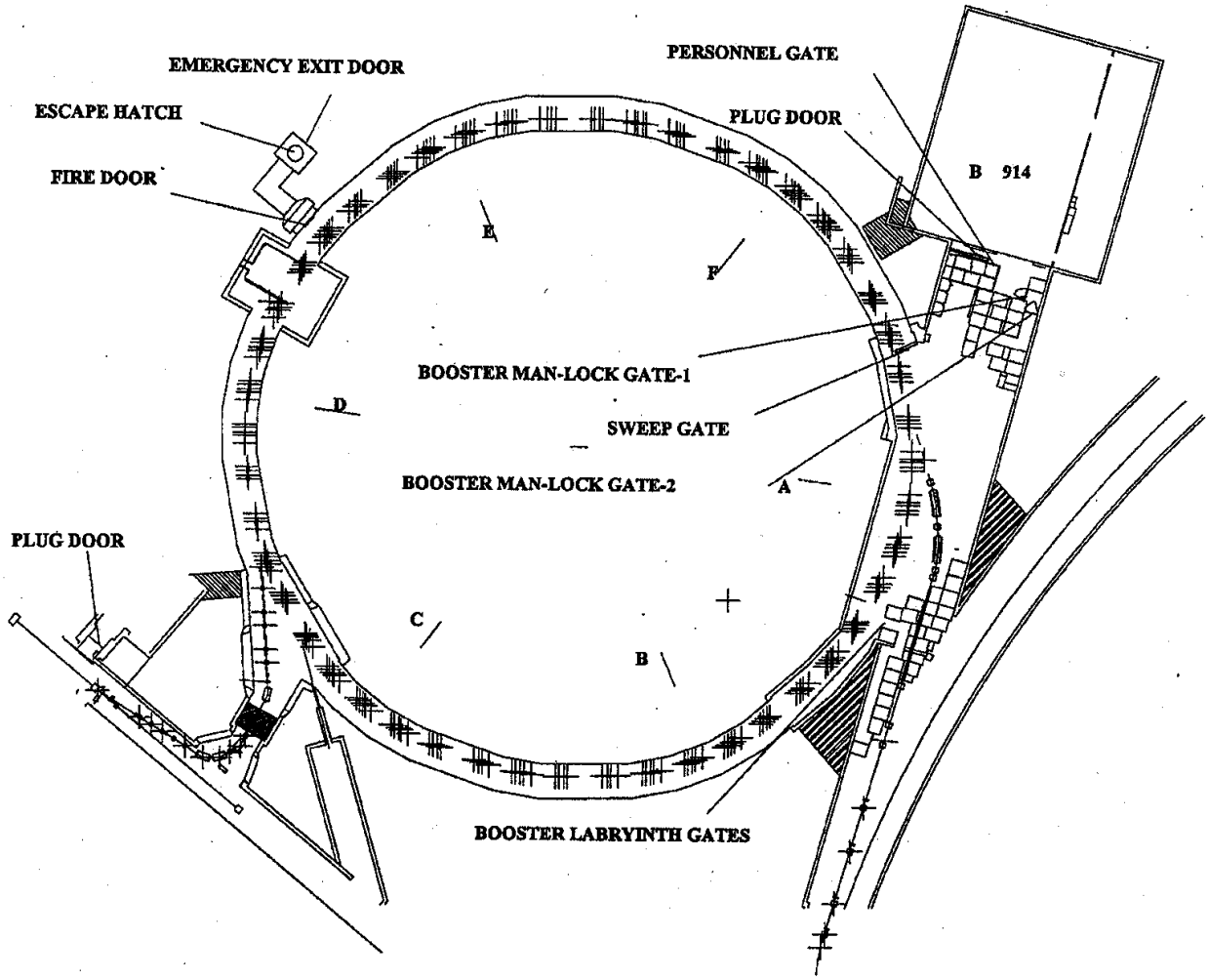


TANDEM TO BOOSTER TUNNEL

Entrance gates at Buildings 907, 908, 941
Obtain key from Tandem Operator
Exit through gates
Emergency exits through the escape hatch at Booster end of tunnel and between Buildings 907 and 908

TTB Line



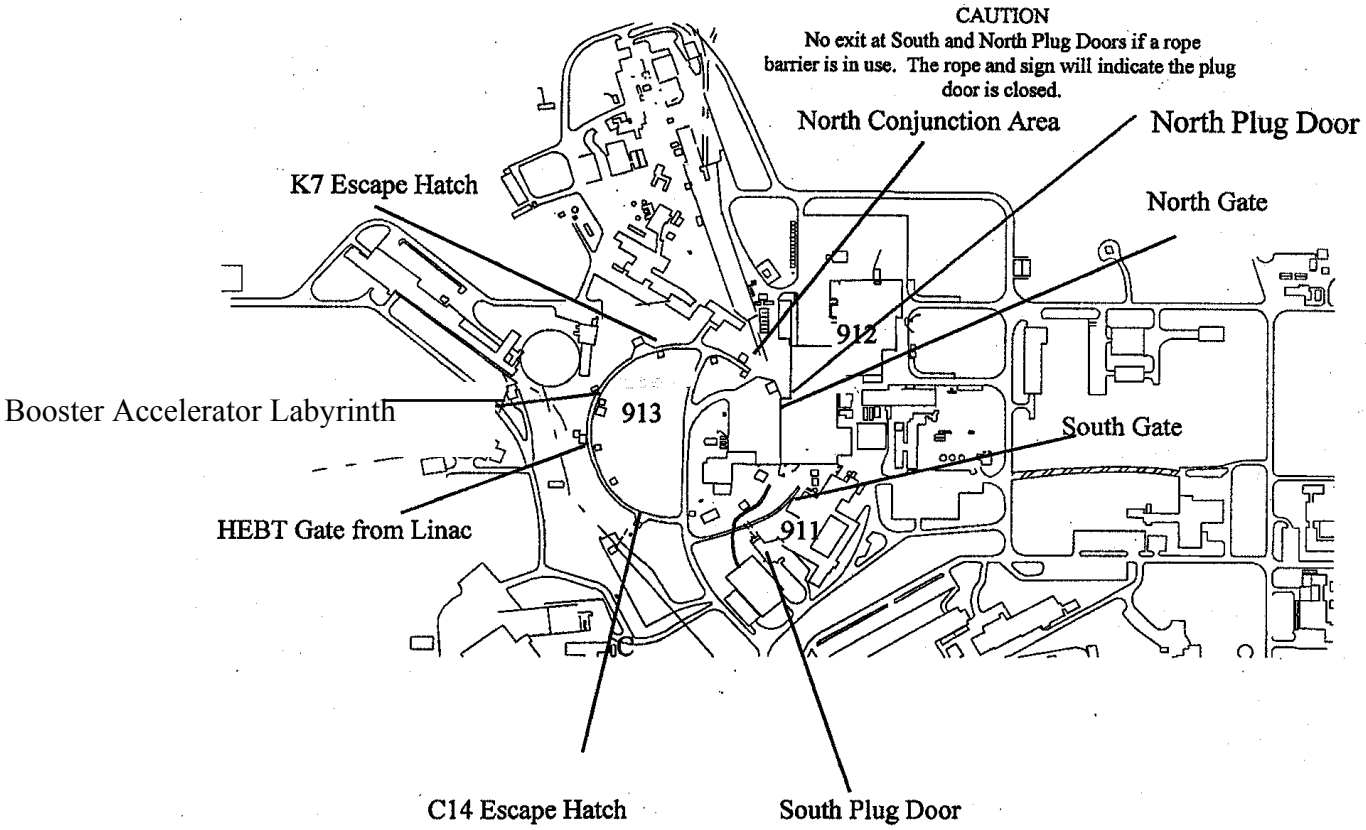


BOOSTER RING BUILDING 942

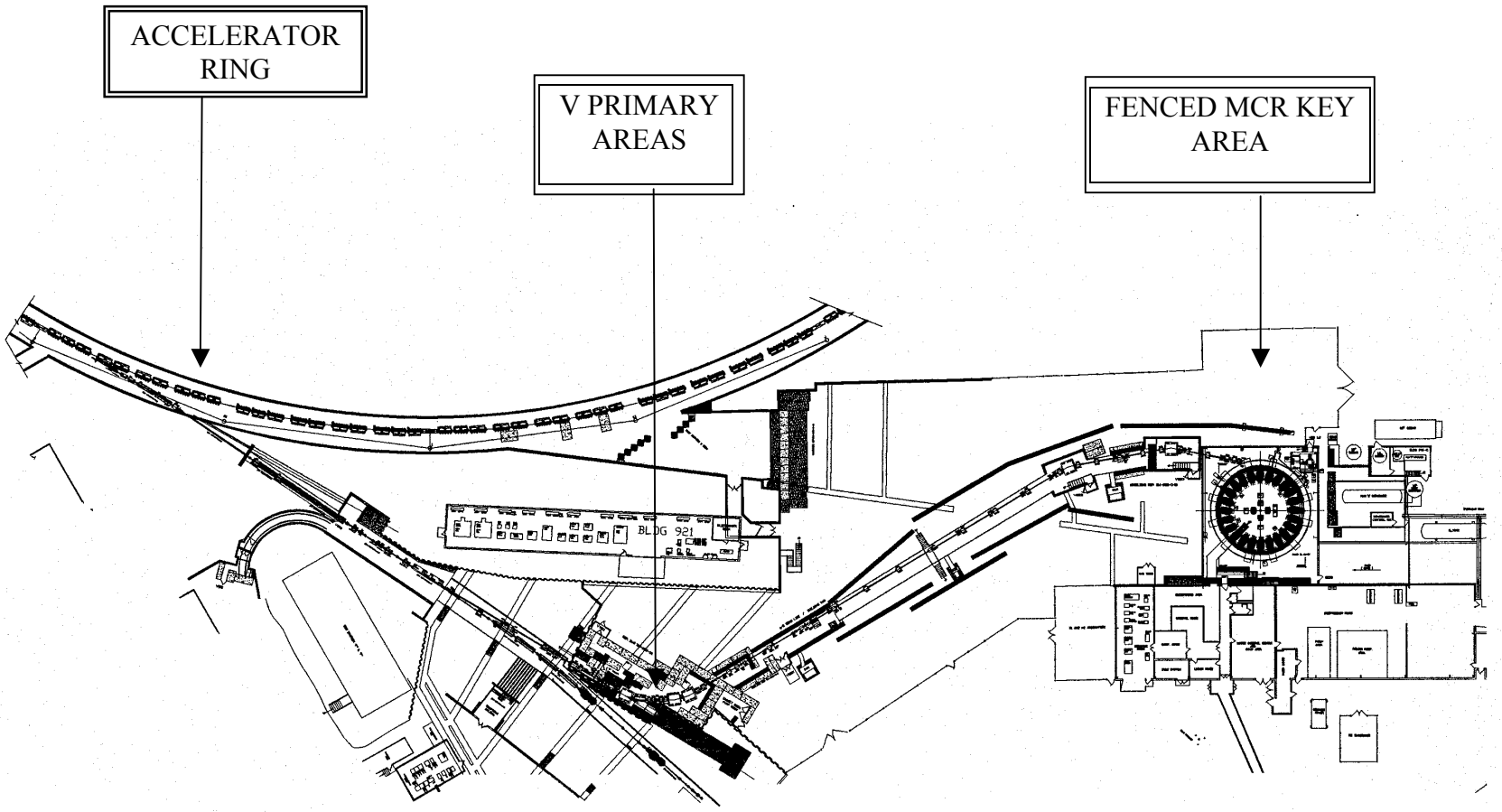
Gate Entrance from Building 914 (Also Emergency Exit)
Plug Door from Building 914 (Equipment Entrance)
Labyrinth from Accelerator Ring with Booster Off
Exits are through 914 Gate and Plug Door (When Plug is Open)
Escape Hatch for Emergencies ONLY, labyrinth is NOT an emergency exit.

AGS BUILDING 913

Entrances at South Gate from Building 911A
North Gate from building 912
North Conjunction Area near Building 919
South Plug Door near Building 911
HEBT Gate from LINAC Tunnel
Booster Accelerator Labyrinth



Exits at: Any gate during Restricted Access
The Gate you enter during Controlled Access
Emergency Exit at Escape Hatches C14 and K7
DO NOT use HEBT Gate or Booster Accelerator Labyrinth



FAST EXTRACTED BEAM AREAS, g-2 EXPERIMENTAL AREA

HANDLING LEAD (Pb)

You will encounter Pb shielding in the primary areas. Please be aware that handling Pb may be hazardous and you are required to use personal protective equipment (PPE) such as gloves, and possibly additional PPE. Pb may be found in brick, sheet, or cast forms, or as wool which is used in Pb blankets. In most applications, the bare metal should be covered or painted if practicable. You need to wear safety shoes in addition to gloves when handling Pb bricks or sheets of Pb. You are not allowed to shape, drill, or otherwise work with Pb in any way that causes it to become dispersed. If you need to work with lead in any way, contact the C-AD ESHQ Division Head or C-AD ES&H Coordinator.

MAGNETIC FIELDS

Shown above is the lowest level posting for magnetic fields; greater than or equal to 5 Gauss. The next highest posting is 600 Gauss. A 5 Gauss posting is posted on doors of assembly buildings, experimental areas, the Collider tunnel, Building 912 and possibly other areas. Additional training or medical approval is not generally required to enter areas posted as shown above. However, if you use/wear an electronic medical device or implant such as a cardiac pacemaker or insulin pump, medical approval is required even for these lower level areas.

Use extreme caution with iron and steel objects when working around magnets with large gaps such as spectrometer magnets. Be sure that magnets are not energized or that a magnet safety plan is followed before free access is allowed to the area. Remember that the field may be effective at a surprisingly long distance.

East Face of the STAR Magnet.
Posting on fence indicates high magnetic field.

GAS ALARMS

Many flammable and combustible gases are used throughout the C-AD facility. Equipment that contains these gases will be labeled. Entranceways to enclosed areas that contain these gases will also be posted to indicate the possible use of the gas and to warn personnel entering the areas not to bring in ignition sources. The gases are used in particle detectors and targets. Large detectors may have electronic warning signs to indicate that the gas is currently in use. The STAR and Phenix detectors at RHIC, for example, use an explosive gas. A yellow strobe light and audible alarm is an indication of a flammable or combustible gas leak. Building 912, the AGS experimental floor, uses a special audible klaxon and large warning signs over the doors are used to warn of gas leaks. If any of these alarms occur, leave the building immediately, wait at least 50 feet away from the building and do not reenter the building until the Fire Captain tells you that it is safe to do so.

Example of one type of posting that you may encounter:

CONFINED SPACE RECOGNITION

A confined space is a space that: (even if not posted "Confined Space")

1. Is large enough and so configured that personnel can bodily enter and perform assigned work,

2. Has limited or restricted means for entry or exit (e.g., tanks, vessels, silos, storage bins, hoppers, vaults, and pits), and

3. Is not designed for continuous personnel occupancy.

If you are entering a space with these characteristics and:

- you are not sure of the requirements for entry,
- you are not sure of the requirements for working within the space, or
- you are introducing any hazard

THEN contact the ES&H Coordinator prior to entry.

HIGH NOISE AREAS

Update: Hearing protection required at all times with equipment on, even if posting indicates for occupancy greater than 5 minutes.

If entering a posted high noise area, as a minimum you are required to:

- wear hearing protection

AND

- complete a BNL web-based training course before entry

Medical surveillance (hearing test) may also be required depending on the decibel levels and length of time in the area. Disposable ear plugs are located at the entrances to high noise areas. For certain areas at C-AD double hearing protection is required, such as the RHIC Helium Compressor Building, Bldg 1005H. Hearing protection or double hearing protection may also be assigned for specific jobs during the work planning process. The disposable ear plugs plus ear muffs are typically used for double protection.

ELECTRICAL SAFETY

This course does **not** allow you to work "on or near" energized equipment.

If you work on electrical circuits that are powered through circuit breakers, disconnect switches and/or fuses, then you must de-energize and LOTO (Lockout/Tagout) the circuits. All workers performing LOTO must have the appropriate training and C-AD authorization. OSHA, NFPA, BNL and C-AD require that all workers performing these tasks be trained.

Training includes:

- Electrical Safety
- Lockout / Tagout
- C-AD Electrical Safe Work Practices

It is always preferred that circuits or equipment be de-energized and LOTO'd before working on them. However, under rare circumstances, it may be necessary to work or conduct testing on curcuits or equiment while they are still energized (i.e.: working "on-or-near" energized conductors; formerly called "working hot"). Under these rare circumstancves, you must have C-A Department-specific training and authorization, and you must work under a C-A Department-specific Energized Electrical Work Permit.

Working on or near energized conductors is defined as working within the Prohibited Approach Boundary where contact with exposed or live parts could cause serious injury or death. Work with voltages/energy/current beyond Range "A" as described in ESH Standard 1.5.0 is considered working on or near energized conductors. Range A is defined as (Reference: SBMS ESH Standard 1.5.0, Electrical Safety, Rev 5):

> Sources limited to an instantaneous release of less than 10 J of energy, AND
> Ac and/or dc voltages less than or equal to 50 V; or
> All ac sources with less than 10mA rms (use 5mA at C-AD) available current; or
> All dc sources with less than 60mA (use 5mA at C-AD) available current.

NOTE: The training and PPE requirements at the Collider-Accelerator Department may be different and more conservative than the Laboratory-wide requirements. If you have questions regarding the electrical safety requirements for your specific situation, then stop and please refer to C-AD contacts available to you, which include: C-AD ESH Coordinator, C-AD Work Control Manager, C-AD ESHQ Division Head, C-AD Electrical Systems Head.

NFPA 70E

NFPA: National Fire Protection Association
70E: Electrical Safety in the Work Place

Newest Concern: ***Electrical Arc Flash Hazards*** (in addition to the already existing concern of electrocution)

In the U.S., 8 to 10 people per day are sent to burn units due to arc flash, mostly from low voltage (120 V) with high-fault current capability.

Biggest impact at C-AD: Personal Protective Equipment (PPE) required for breaker or switchgear operation. Even operating a circuit breaker or fused switch with covers on (≤ 600V ac rms) is considered working "on-or-near" energized conductors and requires training and PPE.

Operation of circuit breakers or disconnect switches requires training and authorization and PPE is also required, even for relatively low voltage such as a 120 Volt breaker.

Working on or near live equipment is not permitted without the correct PPE and the required training.

This may slow jobs down, but we must comply with NFPA 70E.

Some specific hazards at C-AD:

Vacuum ion pumps remain powered and represent high-voltage electrical hazards (5000 Volts). If you are working on a vacuum pump inside an accelerator enclosure, be sure that LOTO is properly implemented and that you are at the correct location since areas look similar.

The Wood's metal system is always powered as is the Access Control System, and both are at 110 VAC. Some Access Control System wiring is 24 V, but most is 110 V. Always assume the wiring in the Access Control System is capable of delivering a serious electrical shock.

FLASH HAZARD

A flash hazard is present when the potential exists for electrical equipment to arc, producing a shock hazard, possible sparks and molten metal spray. For example, this can occur during operation of a circuit breaker or switch, or in situations were electronic components and connections are exposed during testing. If a conductive tool is dropped into these areas a flash event may occur. Care is required in these areas to prevent any inadvertent electrical contact. The potential for electrocution is well known, but arc flash hazard may not be as well known.

LOCKOUT / TAGOUT

Lockout/Tagout (LOTO) is used at the Laboratory for personnel safety from energy sources. These sources include electrical energy, potential or kinetic energy, pressure or any energy source that could injure personnel if left uncontrolled. It is recognized by the presence of a red tag or a lock, and it requires that you obey specific OSHA requirements. In some cases, the equipment cannot be locked and only the red tag is used. In most cases, however, LOTO boots or other commercially available locking devices can be added to the device to enable complete LOTO.

LOTO may also be used to isolate materials, the release of which, could impact the environment.

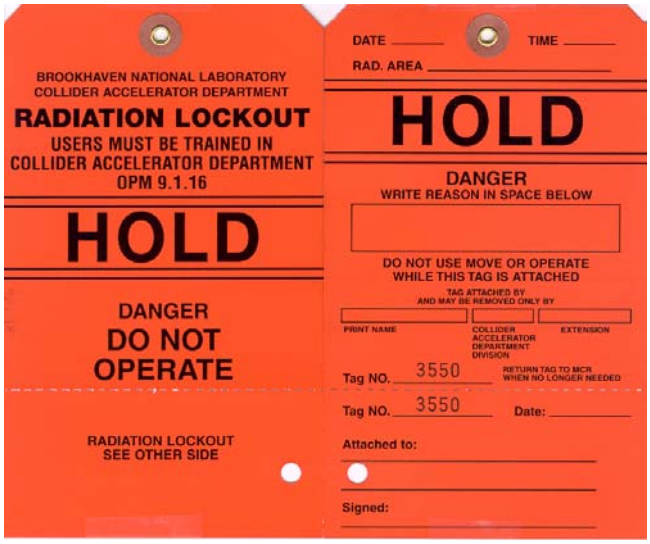
Lockout/Tagout (LOTO) is the practice or procedure necessary to disable machinery or equipment and to prevent the unexpected release of potentially hazardous energy during maintenance, servicing, or construction. An Authorized employee is permitted by the Laboratory to implement LOTO; that is to place and remove locks or tags on equipment. An Authorized employee is trained to recognize hazardous energy sources and methods and means to isolate and control these energy sources. To prevent accidental radiation exposure, electrical shock or other hazards from different sources of energy, only Authorized employees can remove their own personal LOTO locks and tags. However, under rare circumstances, when the individual who attached the LOTO is not available, a committee of three employees can be formed to authorize removal of the LOTO. Membership requirements for the committee are specified in the C-AD Operations Procedures Manual (OPM). These members will be familiar with the area or equipment under the LOTO and they shall determine if it is safe to remove the red tag and lock. Contact the C-AD Main Control Room (MCR) or the C-AD ESH Coordinator if you need to remove someone else's LOTO. A similar procedure is used for Radiation Safety (RS) LOTO.

NOTE: LOTO tags that have been removed should be destroyed or defaced to prevent unauthorized reuse.

Personnel trained to the "Affected" level of LOTO are trained to recognize when LOTO is in effect and are capable of identifying locks and tags used in the LOTO program. However, they are not authorized to place or remove any LOTO tag or lock.

If you work on electrical circuits that are powered through circuit breakers, disconnect switches and/or fuses, then you must LOTO (Lockout/Tagout) the circuits. All workers performing LOTO must have the appropriate training and C-AD authorization. OSHA, NFPA, BNL and C-AD require that all workers performing these tasks be trained. If you or your co-workers fall into this category and you have questions regarding LOTO training requirements, contact the C-AD Training Manager or the C-AD ESHQ Division Head. This C-AD Access Training alone does not allow you to place or remove locks or tags.

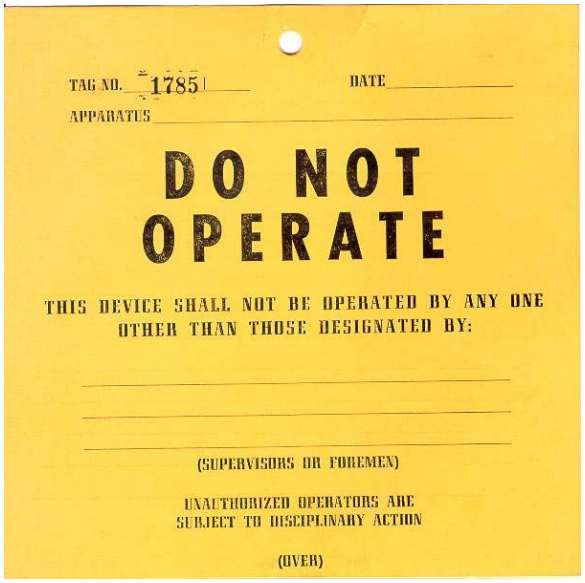
RADIATION SAFETY LOCKOUT / TAGOUT (RS LOTO)



Red "Radiation Lockout" Tags (RS LOTO) are used to inform and warn personnel that equipment is being used to provide radiation protection to personnel. The LOTO is to prevent changes to this equipment. Liaison Physicists, Liaison Engineers, Access Controls Group staff, Operations Coordinators (OC), members of the Radiation Safety Committee, and certain other personnel are authorized to perform RS LOTO. They must follow a specific procedure in order to lock-out and tag-out equipment or beam lines for radiation protection. Equipment or beam lines are generally locked out during barrier modifications or barrier removals, or whenever the Access Control System or Particle Accelerator Safety System (PASS) alone do not provide the required protection. This lockout is required in order to limit beam parameters such as polarity and intensity, or whenever a beam line is not authorized to operate. DO NOT alter equipment that bears the RS LOTO tag.

NOTE: If you are operating an electrical circuit breaker or disconnect switch to perform RS LOTO, then the electrical safety training, PPE and required authorization also applies. If you have questions regarding the electrical safety requirements for your specific situation, then stop and please refer to C-AD contacts available to you, which include: C-AD ESH Coordinator, C-AD Work Control Manager, C-AD ESHQ Division Head, C-AD Electrical Systems Head.

YELLOW "DO NOT OPERATE" TAGS



Yellow "Do Not Operate" Tags are used to inform and warn personnel that altering the equipment may cause damage to the equipment or system, or can have adverse programmatic impact. The equipment should not be altered without consulting the owner of the tag or the system specialist. These tags are used for equipment and/or programmatic protection.

ORANGE TAGS

Access Control System
or
Particle Accelerator Safety System (PASS)

Orange Tags are used to identify devices that are part of the Access Control System or the Particle Accelerator Safety System (PASS). These devices must remain correctly connected and located. In order to help ensure that personnel do not disconnect or alter these devices without following approved procedure, the C-AD Access Controls Group identifies such devices with an ORANGE WARNING TAG. The equipment is used for radiation protection, and most of the system wiring is maintained at 110 VAC so it also represents an electric-shock hazard if tampered with.

- Program disruption and/or electrical shock may occur by overlooking an orange warning tag.
- Tags and signs are often placed only on the front of equipment. Look at the front of equipment before starting work.

Only the owner (the C-AD Access Control Group) of the tags can remove the tags and adjust or move the equipment.

Orange Warning Tag:

In addition to an ORANGE WARNING TAG, equipment specialists document allowable work, such as routine maintenance, that may be performed on PASS or Access Control System equipment. Equipment specialists provide this information for each piece of equipment they connect to the PASS or Access Control System. The Access Controls Group makes these informational documents available to all personnel who work on the equipment. C-AD staff who work on equipment with an ORANGE WARNING TAG must proceed by the guidelines in these informational documents.

Examples of tagged equipment are scintillation detectors called NMCs (Nuclear Measurements Corporation) in experimental areas and Chipmunks (area radiation monitors). DO NOT MOVE these devices since relocation will compromise their effectiveness.

ELECTRICAL SAFETY IN PRIMARY AREAS

Token box located at AGS South Gate

The electrical equipment in primary areas covers a wide spectrum of voltage and current. In order to meet OSHA requirements and BNL rules, a special lockout/tagout procedure is in place for the AGS and Booster rings (the tunnels).

Before workers enter the AGS or Booster tunnels, the Main Control Room Operators lock out about one hundred electrical devices. This procedure is called a Group LOTO. Operators will capture all the appropriate keys under this procedure and lock them in a box in the MCR. The key for this box is called the TOKEN. The TOKEN is placed in a box at the AGS South Gate and/or at the Booster plug door as appropriate. This box is called the TOKEN BOX.

A single senior individual at C-AD is responsible for the TOKEN BOX and will be the first to place a RED LOTO tag and lock on the TOKEN BOX and the last to remove it. After their LOTO is placed on the TOKEN BOX, EACH WORKER entering a ring MAY BE required to place THEIR OWN LOCK AND TAG on the box as well. The need for locking out the box by each entrant DEPENDS ON THE WORK they are to perform. Walk-through of the areas where beam line equipment is not handled does not require a Radiation Worker to add their own lock and tag to the Token Box.

A worker placing their own lock and tag on the token box DOES NOT preclude the need to ALSO lock out the power supply to the specific equipment they are working on.

The C-AD Operations Procedure Manual (OPM) has procedures that define these requirements in detail. The execution of a Group LOTO for a ring will secure the equipment that the C-AD believes to represent potential electrical hazards to personnel entering the ring.

As indicated previously, you MAY BE required to add your lock to the TOKEN BOX. For example, if you intend to work on the magnets or behind them, then you must place your lock and tag on the TOKEN BOX.

If you intend to work on a specific piece of equipment that is connected to its power supply, that is, cables are still connected to the device, then you must LOTO the specific power supply for that device. If you are not sure about your specific LOTO requirements, then please contact the C-AD ES&H Coordinator or the C-AD Work Control Coordinator.

If you enter the ring when certain equipment has been left on for testing purposes, then you MUST have additional training. There may be specific C-AD procedures written for this type of work. You should be notified by the Operations Coordinator (OC) or the responsible Project Engineer under these circumstances.

MAGNET COOLING WATER

Magnet cooling water systems may incorporate electrical buses. They are operated under pressure and required special training to work on. Depending upon the location in the C-AD complex, some magnet cooling water systems may have a radiation field associated with them. They are clearly labeled and should not be handled without proper training and authorization.

Orange tubing typical for magnet cooling water

LASER SAFETY

Lasers must be registered with the BNL Laser Safety Office. This includes higher hazard class lasers (Classes IIIb and IV) as well as lower hazard class lasers (Classes II and IIIa). Classes IIIb and IV require:

- Additional Laboratory training
- Completion of a Laboratory Standard Operating Procedure (SOP).

Classes II and IIIa require a permit.

All lasers need to be reviewed by BNL Laser Safety Office personnel prior to initial use or following modification to a previously reviewed laser. Make sure you are aware of the safety requirements established for lasers in your area. Contact the C-AD ESH Coordinator if you will be installing a new laser or modifying a laser.

FRAGILE EQUIPMENT

Many experiments at the C-AD complex employ many devices and equipment that are fragile such as vacuum windows, scintillation detectors, prototype detectors, electronic cards, connectors and cables. All of these devices require proper training and authorization to perform work on.

All Collider (RHIC) experiments have beryllium beam pipes installed. This material is fragile and toxic. Protection is provided to prevent physical damage.

Care is always required in experimental areas to prevent damage to fragile components of the experiment.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Department safety policy states that each workplace be created and maintained in a manner that minimizes safety and health problems. For some jobs, it is not always practical to completely eliminate the hazards, and protective clothing and equipment is required for safety. Plan your work in advance. Consider whether PPE may be needed. Contact the C-AD ESH Coordinator for review and approval whenever PPE is to be used. Contact the ESH Coordinator if you are unsure of PPE requirements.

FIRE SAFETY

The fire safety program at BNL emphasizes prevention through building design and automatic protection. If you suspect a fire telephone x2222 or 911 and activate a fire alarm (use a fire alarm pull box if one is in the area). These actions notify the Fire Rescue Group and Police Group at the same time. Warn others in the area and evacuate as required. If you think you can combat the fire without putting yourself in danger, a fire extinguisher may be effective. **Never let the fire get between you and your escape route**. Use a fire extinguisher only if you are trained and it can be done safely. Only use a fire extinguisher if you're confident in your ability to put out the fire safely. Determine what is burning and select the appropriate fire extinguisher. Fire extinguishers are classified according to their ability to handle specific types and sizes of fires. If you have any doubt, let firefighters handle the situation.

HARDHAT POLICY

You are required to wear a hardhat:

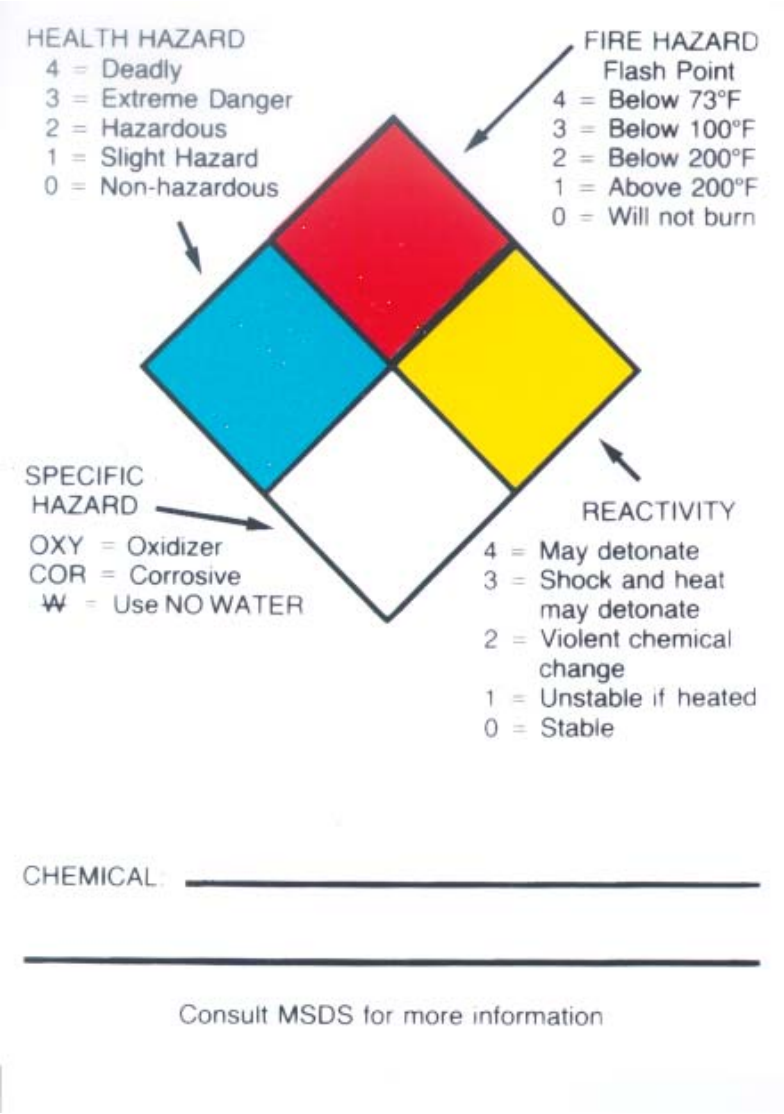
- When people are working overhead
- When overhead cranes are handling objects (do not stand under objects being handled by the crane)
- At all times in a Construction Area

INFORMATION ON HAZARDS YOUR RIGHT TO KNOW

You have the right to know about potential health and safety hazards in your workplace whenever the potential for exposure to hazardous materials exists. Contact the C-AD ESH Coordinator if you would like specific safety and health information. The ESH Coordinator can provide you with information on the Laboratory's policy on hazardous material, how to obtain

Material Safety Data Sheets (MSDS) and how to interpret them. Some of the information that can be found on an MSDS is the name of the chemical, manufacturer, hazardous ingredients, physical characteristics, fire and explosion hazard data, reactivity data, health hazard data, precautions for safe handling and safety control measures.

National Fire Protection Association (NFPA) diamonds appear on various containers or structures that contain hazardous materials:



The ESH Coordinator and explain the labeling system and can provide information on how to select and use protective equipment.

CHEMICAL SAFETY

For your safety, purchased chemicals are inventoried by the Laboratory prior to delivery for end use. If you bring un-inventoried chemicals on site, you must contact the ESH Coordinator to have these chemicals inventoried and bar coded prior to use. All chemicals must be ordered through the BNL Purchase Order System. Credit cards may not be used to purchase chemicals.

PRICE-ANDERSON AMENDMENTS ACT (PAAA)

It is important to make you aware of the absolute requirement to follow all radiation safety rules at C-AD facilities. Federal law (PAAA) provides for enforcement penalties if you do not follow the rules fully. For example, personnel have been the subject of criminal investigations when found to willfully remove a radiation barrier. Thus, we request that you pay particular attention to radiation safety rules.

When signing documents related to radiation safety, an employee is essentially confirming that he/she will do their assigned work according to the rules. The signature does not mean that the employee is guaranteeing that the work will be carried out perfectly or that there is no potential for a violation. It does mean that the employee is performing his/her duties to the best of their ability and has made a good faith effort to comply with the radiation safety rules. A "good faith effort to comply with the rules" means that the employee has familiarized him/her-self with the requirements of regulations that fall within his/her area of responsibility.

Is staff at C-AD accepting additional legal liabilities when signing documents related to compliance with radiation safety rules under the Price-Anderson Amendments Act? The short answer is that the employee incurs no personal liability under the provisions of the Act unless he/she intentionally acts to violate the radiation safety rules.

The Price-Anderson Amendments Act (PAAA) sets up a regulatory scheme for enforcement of radiation safety rules. Rules are set forth by 10 CFR 835: Title 10, Code of Federal Regulations, Part 835 "OCCUPATIONAL RADIATION PROTECTION". Failure to comply with those rules, or to identify and report non-compliance to DOE, subjects the Laboratory to enforcement action.

WARNING

It should be understood that any employee who intentionally violates a radiological procedure, regardless of whether the employee signs any document related to compliance, might be subject to criminal prosecution or other disciplinary action.

DELIVERIES TO C-AD FACILITIES

To ensure that "outside" (non-BNL) delivery personnel do not inadvertently enter radiological areas (or other potentially hazardous areas) without having the appropriate training and authorization, deliveries for the C-AD complex are to be made to BNL Building 100 (during normal business hours). You must still have your own personal information put on the package such as name, BNL location and phone number so that Bldg 100 personnel can contact you after the package arrives at Bldg 100.

When placing an order, inform vendors to put your personal information on the package and state that the delivery is to be made to Bldg 100 (for normal business hours). Packages arriving without a name will likely be sent back.

Untrained delivery personnel entering radiological areas or Controlled Areas could result in a PAAA violation, even if it is an unintentional PAAA violation where the delivery person did not knowingly violate the area's entry requirements.

For deliveries expected during off-hours, advance arrangements can be made with the C-AD Main Control Room if the MCR is in an operating mode and is being manned during the off-hours.

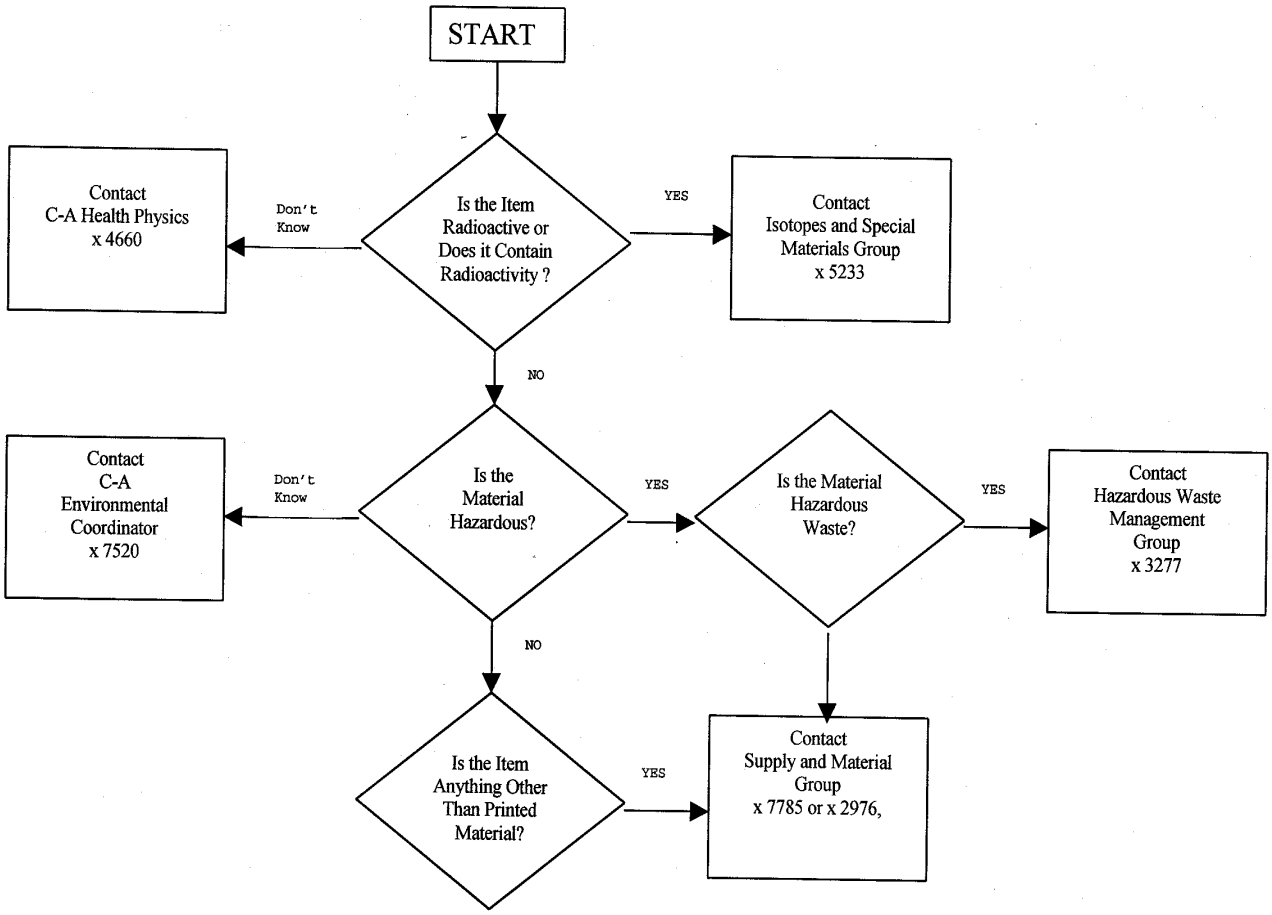
Under no circumstances are deliveries to be made to other buildings in the C-AD complex without approval of the C-AD ESHQ Division Head or the C-AD ESH Coordinator.

REMEMBER: All persons, including delivery people, who enter radiological areas or Controlled Areas must be trained or be escorted by a trained individual, and must wear any dosimetry (e.g.: red-striped TLD) required for the area. A Radiation Work Permit (RWP) may also be required for entry. Escorting requires paperwork and approvals.

In order to facilitate deliveries that require rigging upon arrival, please inform the C-AD Facilities & Experimental Support Section riggers of anticipated rigging needs for your package.

SHIPPING from C-AD or BNL to OFF-SITE

If you are shipping from C-AD or BNL to off-site, then ask yourself the following questions and follow instructions prior to shipping



RADIATION AREA DEFINITIONS

Controlled Area -- any area where access is controlled due to the presence of radiation above natural background levels or due to the presence of man-made radioactive materials. As a minimum, these areas are posted Controlled Area. These areas are less than 5 mrem per hour general area dose rate.

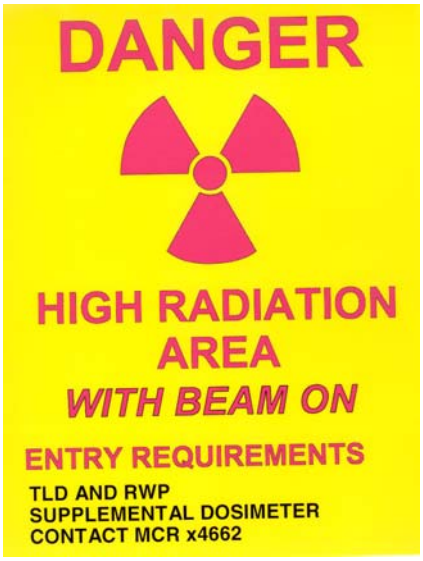
Radiation Area -- any accessible area where an individual may receive a whole-body dose greater than 5 mrem in one hour at 30 cm (about 1 ft). As a minimum, these areas are posted Radiation Area, TLD Badge Required.

High Radiation Area -- any accessible area where an individual may receive a whole-body dose greater than 100 mrem in one hour at 30 cm (about 1 ft). As a minimum, these areas are posted Danger, High Radiation Area, RWP and TLD and SRD Required.

Very High Radiation Area -- any accessible area where an individual may receive a whole-body absorbed-dose greater than 500 Rad in one hour at 1 m (about 3 ft). These areas are not posted at C-AD since they are not accessible.

RADIATION HAZARDS

Example of a posting at C-AD complex:



PRIMARY BEAM

Do NOT enter PrimaryAreas improperly !!

Primary Areas (where beam travels: accelerator rings, transfer lines, target rooms … etc):

Radiation hazards are the most extreme (are to be considered lethal with beam on);

Key access through posted gates is required;

Shielding, walls, fences, and/or other barriers are in place around the beam path.

PRIMARY BEAM: in-beam dose rates up to 10^{14} mrem/hr from hadrons.

SECONDARY BEAM: in-beam dose rates up to 10^{11} mrem/hr from hadrons, and leptons.

FAULTS: radiation penetrating through shielding from unplanned beam losses may lead to doses of several tens of mrem from neutron and gamma radiation near shielding or fences. Faults may last a few seconds before machines are interlocked off.

NORMAL OPERATIONS:

- About 1 to 2 mrem/hr or less in continuously occupied areas from neutron and gamma radiation that penetrates the shielding at the accelerators, and < 1 mrem/hr at the Collider (RHIC).
- Accelerator (AGS, Booster) magnet cooling water lines are 100's mrem/hr during running periods and for several minutes post shutdown (gamma).
- Air activation at the accelerators may reach 100's mrem/hr from airborne radioactivity inside target caves for several minutes post shutdown (beta, gamma). During running periods, air activation may exist outside target caves:
  - but requires no special protection unless instructions are given by Health Physics personnel or posted at the work area
  - decays within minutes after the beam is turned off
  - can be reduced by using solid doors or other special barriers
- Short-lived contamination (30 minutes) from air activation in primary beam lines. Up to 5000 dpm per 100 cm^2 of floor surface for several hours post shutdown (beta, gamma).

RESIDUAL RADIATION AT ACCELERATORS:

- Primary beam components are up to 10,000 mrem/hr (gamma).
- Targets are up to 50,000 mrem/hr (gamma). V target may be 100,000 mrem/hr or more immediately after shutdown.
- Primary shield blocks inside target caves are 100's mrem/hr (gamma).
- Long-lived radioactivity created in soil near targets, beam stops, and beam scrapers (100's of mCi of tritium and ^{22}Na).

First entry into a Primary Area after beam is turned off:

The first entry into a primary area after beam has been turned off is made by a Radiological Control Technician (RCT) to perform a radiation survey. This is to assure that appropriate decay time has been allowed to pass before other personnel are allowed access. Contact MCR before first entry.

The principal radiation hazard associated with the C-AD primary areas is derived from high level residual radiation. Exposure to this radiation results from working on or near activated machine components, beam stops, shield blocks, cooling water, and activated air in the primary beam

enclosures. Residual radiation is more a concern in accelerator primary areas such as the LINAC tunnel and the AGS & Booster rings, versus the Collider (RHIC) primary areas. The Collider has residual radiation levels generally below 1 mrem/hr, except near the beam dumps which are at higher levels.

Direct exposure to the beam is not possible if areas are entered properly. However, exposure to radiation from unplanned beam losses in areas adjacent to primary areas is possible. This may result from brief faults lasting a few seconds such as during a beam crash due to loss of a steering magnet power supply.

Examples of Estimated Radiation Levels Following High Intensity Proton Running		
AREA	LOCATION	ROUTINE RADIATION LEVEL mrem/hr
LINAC	BLIP Y	500 to 1000
	Booster Interface	500
Booster	Inside of Ring	10 to 200
	Outside	1 to 100
	Extraction Area	200 plus
AGS	Inside of Ring	100 to 10,000
	Outside	1 to 1000
	Extraction Area	10,000
Switchyard and Beam Lines	Near Center of Magnet Gaps	10 to 10,000
Target Caves	Inner Gate	100 to 2000
	A-D Targets	50,000
	V Target One Week Post Shutdown	300,000
Collider*	Collider Tunnel	< 5

* Collider (RHIC) residual dose rate based on operations consisting of heavy ion acceleration.

Radiation Levels, Area Names, Training Required		
Allowable Radiation Level	Area Name	Training Required
< 5 mrem/hr < 100 mrem/year	Controlled Area	General Employee Radiological Training (GERT) * C-AD Facility Specific Training
> 5 mrem/hr < 100 mrem/hr	Radiation Area	Rad Worker 1 Training * C-AD Facility Specific Training
> 100 mrem/hr	High Radiation Area	Rad Worker 1 * C-AD Facility Specific Training

* Contact the C-AD Training Manager for facility-specific training requirements

The accelerator complex has many posted Radiation Areas. Dose rates in these areas may be greater than 5 mrem/hr. These areas are marked-off by ropes, fences, building walls or other barriers. All entrances, every forty feet of fence or rope, and some Hot Spots are posted with Radiation Area signs. In order to work in, or pass through, Radiation Areas without an escort, you must complete Radiation Worker 1 training and C-AD facility-specific training.

In primary areas, radiation levels may be greater than 100 mrem per hour and up to several 1,000 's of mrem per hour at some locations. In order to work in primary areas you must complete Radiation Worker 1 training plus C-AD facility-specific training.

C-AD ADMINISTRATIVE CONTROL LEVELS (ACLs)

and

DOE LIMITS

(for personnel radiation dose)

Administrative Control Levels (ACLs) are an integral part of the dose reduction scheme at BNL and the C-A Department. These administrative levels are LESS than the dose limits set by DOE and Federal Regulations. The administrative levels help assure that we do not violate DOE limits.

C-AD Administrative Control Levels for Radiation Workers (RW-1 Trained individuals):

Period	Maximum Individual Dose ACL (mrem)	Individual Dose ACL with Line Authority Approvals (mrem)	
Calendar Year	1000	1000 to 1250	(C-AD Chair Approval)
		1250 to 2000	(Lab Director Approval)
Daily	100	100 to 200	(Approval will be on RWP)

C-AD Administrative Control Levels for Visitors, Untrained Individuals and Minors:

Untrained Individuals, Visitors

25 mrem per year

A limit of 50 mrem per year is allowed with written permission from the C-AD Associate Chair for ESHQ and concurrence from the BNL Radiological Control Division.

During a high-intensity proton run (Bldg 912 SEB Lines - Slow Extraction Beam) C-AD management DOES NOT ALLOW untrained persons into the experimental areas since exceeding the 25-mrem limit is possible in one day.

Minors

25 mrem per year

Minor (< 18 years) dose limit is 25 mrem per year and parental consent is required. Minors are not allowed to ***work*** in radiological areas but are allowed to visit or tour radiological areas.

Pregnancy

After a female Radiation Worker voluntarily notifies C-AD management in writing that she is pregnant, she is considered a "declared pregnant worker" for the purpose of fetal and embryo radiation protection. The dose to the fetus during the gestation period is to be no greater than 350 mrem at a rate no greater than 40 mrem per month. **Given that there is marginal sensitivity to detect low-level neutron dose (with the TLD), supervisors shall not employ declared pregnant workers around beam lines during high-intensity proton operations.** After a person voluntarily notifies C-AD management that she is pregnant, **she must follow-up and notify management in writing when she is no longer pregnant.**

The following are DOE dose limits as prescribed by Federal law. These limits are similar to those set for other radiation workers such as those working at commercial nuclear power plants or at hospitals. Note that the BNL and C-AD Administrative Control Levels (ACLs) are less than the legal limits.

ANNUAL DOE LIMITS (and ACL)

Dose of Interest	Annual Limit (mrem)	Annual ***DOE*** Administrative Control Level (ACL) (mrem)
Whole Body	5000	2000
Declared Pregnant Worker	500 for the gestation period	-
Lens Of The Eye	15,000	-
Hands, Forearms, Feet, or Lower Legs	50,000	-
Any Individual Internal Organ (Not Lens of Eye) Or Skin	50,000	-
Minors, Untrained Persons/Visitors, and Public	100	-

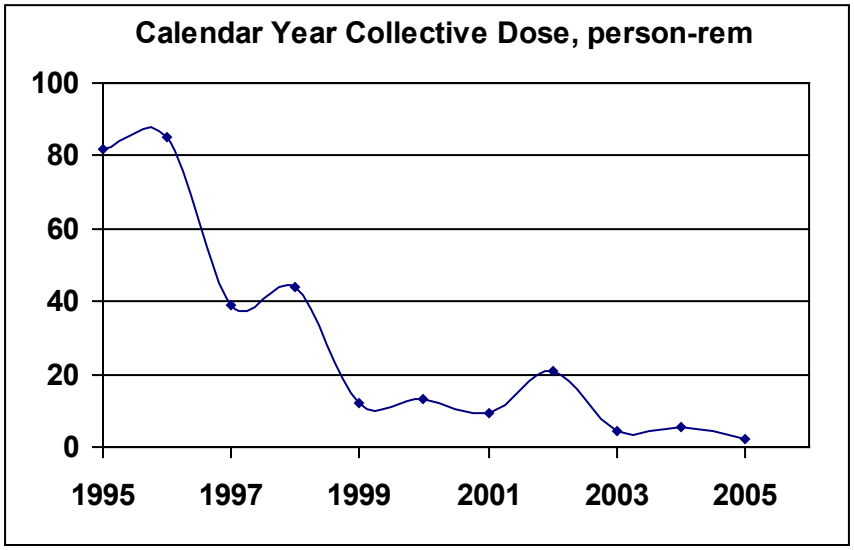
C-AD EXPOSURE PHILOSOPHY

Radiation exposure at C-AD must:

- Have A Net Benefit
- Be As Low As Reasonably Achievable (ALARA)
- Be Within Limits

Annually, about $100,000,000 will be expended to operate accelerators for experiments at the C-AD complex. Once an experiment is configured, valuable scientific information is obtained. It is difficult to estimate the economic worth of this information, but there is considered to be a net benefit to the dose received from conducting the research. Dose received from eating, drinking or smoking in a Radiation Area or a High Radiation Area obviously has no net benefit and is not permitted. Doing so would increase the time spent in the area and correspondingly the dose, without increasing the net benefit. In addition, taking a shortcut through a radiological area in order to save time or to avoid inconvenience is not an appropriate practice.

The collective dose, which is the sum of dose to all radiation workers at C-AD, has declined in recent years.



The ALARA Committee consensus is that the majority of this collective dose comes from working on small short-duration jobs. The Committee wishes to capture all Self Reading Dosimeter (SRD) dose for all jobs in High Radiation Areas and Contamination Areas. The Committee would like to determine which dose goes with which job. Your cooperation in entering self-reading dosimeter (SRD) data each day on the correct RWP log is required and will help define jobs where further dose reduction can be achieved.

ALARA STRATEGIES

Basic ALARA strategy on the part of the worker revolves around effective use of time, distance and shielding. Time tends to have a linear impact on dose reduction, distance a quadratic impact, and shielding an exponential impact. ALARA may also be incorporated into design and operations. The following are examples of ALARA strategies at C-AD:

- Track and reduce unnecessary beam loss
- Design and add temporary shielding
- Hold discussions in areas where the radiation level is the lowest
- Use remote handling equipment
- Use portable power tools
- Plan work and practice
- Install quick disconnect and alignment features on beam-line components
- Install radiation resistant devices
- Assemble parts out of the area
- Identify lower dose rate areas
- Use mirrors and video cameras

ALARA is applied most effectively at the design stage of a facility or of a piece of equipment.

In the past, the most dose reduction has come by way of Accelerator Improvement Projects (AIP). We have improved the reliability of the vacuum system, the beam injection system, and the beam extraction system. Additionally, the Experimental Support & Facilities Division has designed radiation-hardened magnets that can operate properly after very high doses. This has resulted in fewer repairs, which in turn reduces the dose burden because we are working less frequently on broken, activated equipment. Additionally, new accelerator systems have been installed to achieve better control of beams, which results in less activation of equipment.

Information on collective dose associated with specific jobs is available to the C-AD ALARA Committee and C-AD Management. The C-A Department learns which jobs or experimental areas are associated with the highest dose. This in turn may lead to a future AIP.

RADIATION WORK PERMITS (RWP)

A Standing/General RWP or a Job Specific RWP is required for entering or working in **any** radiological area at the Collider-Accelerator Department complex. Radiological areas include Radiation Area, High Radiation Area, Contamination Area. All personnel entering or working in any radiological area at C-AD must follow the requirements of the C-AD Radiation Work Permit (RWP) for the area.

A Job Specific RWP is required for jobs predicted to cause greater than:

20 mrem to an individual
or
200 person-mrem to a work crew

A Job Specific RWP is also required for jobs that may alter radiological conditions or involve unpredictable or changing radiological conditions.

Individuals signing onto a RWP must read the RWP and are signing that they are aware of, and will comply with, the requirements of the RWP.

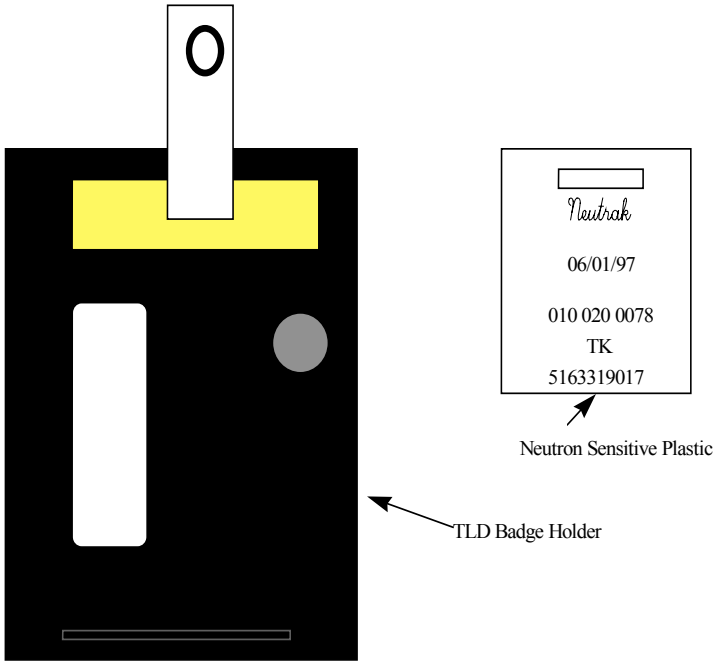
C-AD's Standing/General RWP for "Radiation Areas":
At C-AD, there is a Standing/General RWP for "Radiation Areas" for: ***Routine Entry for Inspections, Data Collection, Tours, or Routine Work Activities Performed by a System Specialist.*** This RWP is valid for 1 year. This means that you only need to sign in once for the 1-year period. The 1-year period is defined on the RWP by the "Work Begins" and the "Work Ends" dates. A copy of this RWP for you to sign is located at the C-AD Training Office (Bldg 911), or you may contact and the C-AD Health Physics Group. This particular Standing/General RWP is for Radiation Areas, **NOT** for High Radiation Areas. There are separate RWPs for work in or entry into High Radiation Areas.

C-AD RWPs for "High Radiation Areas":
Signing in and out of High Radiation Areas (and Contamination Areas) is required once for each job or once each day for multi-day jobs – NO EXCEPTIONS. See "ENTERING CONTAMINATION AREAS or HIGH RDIATION AREAS".

PERSONAL DOSIMETRY

Thermo luminescent Dosimeter - TLD

Note: To be issued a permanent or temporary TLD at the C-A Department, the general practice is that you have Radiation Worker-1 Training and C-AD facility-specific training.



The TLD **monitors** your exposure to beta, gamma, and neutron radiation. It offers **no protection** from radiation..

- The TLD is the basis for the legal record of your occupational dose.
- Permanent or Temporary TLDs are exchanged on a monthly basis. Currently, TLD exchange day is the first Friday of each month. The actual exchange will typically occur over the weekend.
- Trained personnel receive a regular or Permanent or Temporary TLD, which have a blue or yellow stripe on the front of the badge. The color alternates monthly. A red stripe on the front of the badge identifies a visitor (untrained person) TLD. See "TLD's for VISITORS" below.
- TLDs must be worn on the front of the torso, between the waist and the neck unless directed otherwise by Facility Support personnel.

- TLDs are worn when required by signs or postings, Radiological Work Permits, and when directed by Facility Support personnel. A TLD is always required for Radiation Areas, High Radiation Areas and Contamination Areas, even if not stated on the posting. A TLD is also required for Controlled Areas when indicated on the posting. There are several Controlled Areas at C-AD that require a TLD - pay attention to postings.

- Either following a job or at the end of the work shift, return the TLD to the badge board. Be careful to place it in the correct slot. Temporary ("TEMP") or Visitor (red-striped) badges should not be placed in slots designated for permanent badges. Permanent badge slots have assigned numbers.

- If you leave BNL (employment is terminated or your guest appointment has expired) be sure to leave your TLD on a badge board, or turn your TLD in to Facility Support personnel or to the office who issued you the TLD.

- TLDs issued at BNL should not be worn at another facility and dosimetry issued from another facility should not be worn at BNL. At issue is that your dose should be recorded only once for any time period monitored, and it should be recorded by the facility at which the dose was received.

- You must never use someone else's TLD and never lend your TLD for someone else to use. Violation of this policy can result in serious disciplinary actions.

- If while in a TLD area your TLD is lost, damaged, or contaminated, place your work activities in a safe condition, immediately exit the area and notify Facility Support personnel or the C-AD ESHQ Division Head.

- Report any lost badge immediately to Facility Support personnel or the C-AD ESHQ Division Head.

- Individuals wearing a visitor TLD (red-striped) require an escort in the area. If you encounter an unescorted visitor within a TLD area, immediately escort them out of the area. DO NOT REMAIN IN THE AREA AS THEIR ESCORT UNLESS YOU HAVE BEEN PROPERLY APPROVED TO DO SO.

Note: "Facility Support" personnel is synonymous with "Health Physics" personnel at C-AD.

Regarding the seriousness of proper use of personnel monitoring devices, the following is an excerpt from an article published in *BNL Radiological News***,** May 2004:

> Recently there have been several noncompliances concerning the use of thermo luminescent dosimeters (TLDs) at Brookhaven National Laboratory (BNL) (i.e., worker wears another person's TLD, worker does not exchange TLD at month's end but wears it for many months). One of these issues resulted in BNL having to report the noncompliance in the Department of Energy's (DOE) Noncompliance Tracking System (NTS), which is the DOE system for reporting nuclear safety noncompliances. It is important that trained radiological workers follow the requirements for use of personnel monitoring devices.

If you are going to have a medical procedure that will inject a radioactive material into your body (such as technetium or thallium) please notify the Facility Support Representative, ESH Coordinator or ESHQ Division Head. They will set up restrictions on your use of your TLD so that the medical dose is not recorded on the TLD. Your TLD is intended to record occupational dose and not medical dose.

The TLD monitors exposure and verifies the effectiveness of the C-AD radiation protection program. TLDs are read by the BNL Radiological Control Division (or are sent to an off-site lab) and monthly results are back after a few weeks. Emergency TLD read-out can be done in a day.

Two neutron sensitive plastics may be added to the C-AD TLD badge during high intensity proton running periods. These plastics are used to record neutron dose. The plastics more accurately interact with a broader spectrum of neutron energies, which is different from the TLDs.

TLDs "see" greater than 5 mrem per month. The plastics "see" greater than 30 mrem per month. The accuracy is ± 20% for gamma and less accurate for neutrons. Do not expose the TLD or plastics to heat, get it wet, take it home, wear it under your clothes or tamper with the TLD or plastics. The accuracy of the exposure data is dependent on proper care and use.

The AGS experimental floor (building 912) requires that a TLD be worn at all times because this building is posted as a Radiation Area.

Several areas at C-AD are posted High Radiation Area. You are required to wear <u>both</u> a TLD and a self-reading dosimeter (SRD) when entering these areas. The SRDs issued at C-AD are digital, and they alarm at pre-set set points. Examples of posted High Radiation Areas at C-AD are Booster and AGS rings (the tunnels), transfer lines, target caves, shield tops and some secondary experimental areas. Some areas are posted "High Radiation Area with Beam On". If you are unsure of the beam status, or you are unsure of any requirements for entering or working in any radiological area, contact the C-AD Work Control Coordinator.

TLD's for VISITORS (Untrained Persons)

Red-striped TLD

(25 mrem/year MAX allowed for visitor/untrained person)

The term “visitor” here also means an “untrained” person.

- Visitors are not expected to work
- A Red-striped TLD is issued to Visitors for a limited period
- Red-striped TLDs are to be returned to their assigned badge board EACH DAY
- An Escort is required at all times for a Red-striped Visitor TLD wearer

A visitor red-striped TLD may be issued to untrained people with the approval of the C-AD ESHQ Division Head or designee. A visitor badge can be issued by the C-AD Training Office during normal business hours, and by the on-duty Radiological Control Technician (RCT) during off hours. For off-hours, prior arrangements should be made with the C-AD ESHQ Division Head or the C-AD Training Office.

The expected estimated dose to the visitor (untrained individual) must be understood by the escort based on the areas the individual will enter and is LIMITED TO 25 mrem. A visitor with a red-stripe TLD is required to be escorted by a trained Radiation Worker at all times.

Proper escort paperwork must be completed and approved. See the C-AD Training Manager or the ESHQ Division Head for guidance and approvals.

SELF READING DOSIMETERS (SRD)

A digital alarming Self Reading Dosimeter (SRD) is required for entry into High Radiation Areas and Contamination Areas at C-AD.

The purpose of the self-reading dosimeter is to allow personnel to monitor their own exposure and compare it to the daily C-AD administrative control level (ACL) of 100 mrem. Self-reading dosimeters have ± 20% accuracy for gamma. They only respond to gammas. They are not calibrated to measure neutrons.

Always:

- Log all measured dose on the High Radiation Area RWP log (see"ENTERING CONTAMINATION AREAS or HIGH RADIATION AREAS")
- Wear your SRD on your torso outside of clothing

Digital dosimeters are:

- Easy to read
- Chirping function warns of increasing radiation field
- Alarming function warns of high accumulated dose and high dose rate
- Required in order to enter or work in High Radiation Areas and Contamination Areas

The C-AD Training Office can issue SRDs and can provide you with instructions on how to operate the SRD (e.g.: turn on, turn off, re-zero). SRDs are set to alarm at certain set points. Typically, these set points are: 18 mrem total accumulated dose, and 90 mrem/hour dose rate. These set points may be changed by the C-AD Health Physics Group as appropriate.

If while in a High Radiation Area your SRD starts alarming or the chirp rate increases unexpectedly:

- stop work and place work area in a safe condition
- notify others in the work area
- immediately exit the area
- notify a C-AD Radiological Control Technician and your supervisor - - your TLD badge may need to be read-out immediately

You should always check the SRD before using it:

- check the calibration due date
- read the SRD
- re-zero the SRD if you wish (contact the C-AD Training Office if you need instructions)

ABNORMAL RADIATION LEVEL

If you encounter either of the following conditions:

- ♦ self-reading dosimeter (SRD) is alarming or the chirp rate increases unexpectedly
- ♦ radiation levels are not what were anticipated based on the RWP

then:

- stop work and place work area in a safe condition
- notify others in the work area
- immediately exit the area
- notify a C-AD Radiological Control Technician and your supervisor - - your TLD badge may need to be read-out immediately

CONTAMINATION

BNL Contamination Worker Training is required to work in any C-AD Contamination Area. This is in addition to BNL Radiation Worker Training and facility-specific training.

Radioactive contamination at C-AD is expected mostly in areas of high activation such as target areas or beam extraction areas.

Through design, C-AD eliminates contamination problems associated with targets and with air activation near target cave entrances. C-AD monitors target temperature and the air near the target itself for airborne radioactivity. Operation of high intensity targets has been successful over the past several years.

Radioactive contamination, however, can still be a concern. In general, any material inside primary areas is considered activated material; until checked as non-activated. Activated material that becomes dispersed or dispersible is a contamination concern. The following materials or activities are examples of what could be a contamination concern at C-AD:

- Leaking water from magnet cooling systems
- Drilling or grinding of materials in radiological areas
- Leaking oil from vacuum systems in primary areas
- The contents of fire extinguishers or gas cylinders that reside in primary areas during beam operations
- Accidental spill of liquid target material after irradiation
- A failed target

Some work requirements for Contamination Areas at C-AD:

- You must be a trained Contamination Worker
- C-AD RWP required
- C-AD Radiological Control Technician (RCT) job coverage required
- SRD required
- You can be escorted by a trained Contamination Worker into a Contamination Area , but NOT to do work
- You cannot be escorted into a High Contamination Area
- Check (frisk) all removed items, and yourself, for contamination

Skin or clothing contamination is a reportable DOE occurrence. The total number of reportable occurrences is a performance indicator that C-AD must track as required by contract with DOE. We are obligated by contract to try to reduce the annual number of occurrences. Contamination incidents involving ingestion, inhalation, skin or street clothes are avoidable if you follow the rules that are posted in these areas and follow the RCT's direction.

It is C-AD management's practice not to leave areas as Contamination Areas. The C-A Department prefers to remove or clean-up contamination so that the area can be released as a non-contamination area.

Some additional information:

- During high intensity proton running there is measurable air activation near the target entrance gates. Within an hour after beam is turned off, this activation decays away.
- Some primary areas are posted as Contamination Areas and have measurable levels of moderate-lived (months) contamination on the floor. You may be required to wear protective covers over your shoes in order to enter these areas. You will be required to take Contamination Worker Training to work in these areas.
- If pre-arrangements are made, the C-AD Facility Support Group may be able to provide facility-specific training for working in C-AD Contaminated Areas.
- The BLIP spur in the LINAC is a Contamination Area.
- Experience shows contamination may spread to beam-line components and even onto experimenter's equipment in secondary areas.
- With the exception of a job entailing removal of a failed target, no C-AD area has been found to have airborne contamination at a level requiring the use of respirators.
- Special care should be taken to prevent your clothing from becoming contaminated with activated pump oil, or loose activated debris in or near the target caves.
- Special care should be exercised when moving vermiculite bags that are used as fire stops in cable trays in primary areas.
- Use sensible work practices around greases, oils, broken shield block, rust or where you might repair damaged equipment that is covered with smoke or soot in primary areas.

- If you are going to produce or work with dispersible radioactive material, you must consult with the C-AD Radiological Control Division (RCD) Representative prior to the start of work.

- Work involving dispersible radioactivity must be performed under a job-specific Radiation Work Permit.

Some contamination is not easily detected. Allow the RCTs to make an accurate determination of the beta- and gamma-emitters that might be present prior to beginning a job in a Contamination Area. They have detection capability that can be optimized to find the types of radioactive materials that might be present at C-AD.

ACTIVATED MATERIALS

Labels For Shielding

- Some of the large activated concrete and steel blocks & plates at C-AD are painted with a colored radiation symbol and the word "RADIOACTIVE".

The color indicates the maximum level of radiation at 30 cm (about 1 ft) from any surface:

Green	< 5 mrem/hr
Yellow	5 to 100 mrem/hr
Red	>100 mrem/hr

- Lead bricks, small concrete and steel blocks: the ends of these items are sometimes painted with the appropriate color.
- Some shield blocks may have Radiological Material Tags affixed (g-2 shield blocks).

Labels For Equipment

- A tag or label is placed on radioactive equipment or hardware indicating its residual radiation level, the surveyor's name, and date.

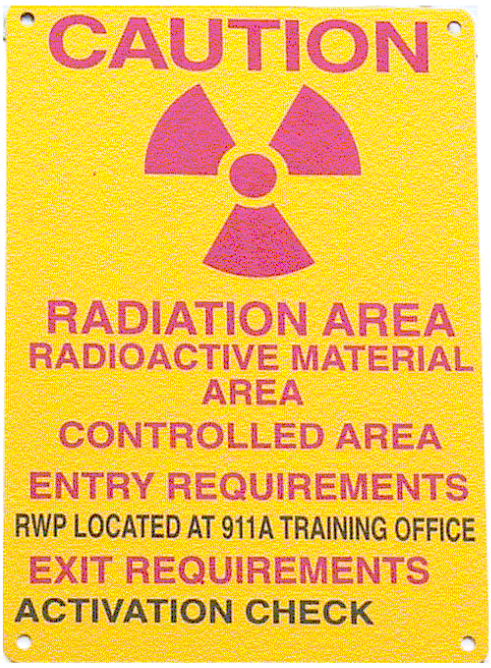
Note that a grouping of radioactive materials tends to add to the total radiation level, which may be well above the level marked on a single item in the group.

Targets, flags, target holders, or any other objects that are exposed to primary beam can become highly radioactive and are to be handled with special care in order to avoid excessive and unnecessary exposure.

At C-AD you will encounter posted Radioactive Material Areas that contain activated materials. Primary Areas are essentially always posted Radioactive Material Areas. Radioactive Material Areas could also be non-primary areas, such as Buildings 912, 922, and 923, the steel yard and the block yard. Not all radioactive material in a posted Radioactive Material Area is tagged while it is within the area. An activation check is required to remove such material from the area. Pay attention to postings.

RADIOACTIVE MATERIAL AREAS

ACTIVATION CHECK REQUIRED



Above is an example of a posting that indicates "Activation Check" under Exit Requirements.

This posting means you **must not** release items from the area without having the items checked (surveyed) for activation, and tagged if activated.

- This training does not qualify you to perform this check. A Radiological Control Technician (RCT) must perform the check. Contact the C-AD Health Physics Office.
- Activation check has nothing to do with checking yourself for contamination upon exiting a posted "Contamination Area".

- In order to remove items from C-AD areas posted “Activation Check”, an RCT must check the material for activation. Activated equipment must be properly tagged.

Some locations may have background radiation levels that preclude performing the activation check in accordance with Facility Support Procedures (FS-SOP-1000) at the area's exit location. In these cases, if coordinated with the C-AD Health Physics Office, it is permissible to transport the material to an area of suitable background in order to perform the activation check. The movement of these materials applies ONLY TO "activation check" required areas. Any material leaving a contamination, airborne radioactivity or dispersible area requires an RCT survey at the area's exit location.

Only you can prevent untagged radioactive materials from leaving C-AD Radioactive Material Areas and primary areas. Ordinary items inside primary areas may not bear labels and must be checked before removal from the area, and tagged if activated. They could find their way into general office areas or waste streams unless you follow the rules. This violates federal law under 10 CFR 835 and results in an investigation to find the reason for the violation.

NOTE: The intent here is that any item that is possibly activated material must be checked. Generally, no item may be released from areas posted "Activation Check" without a Radiological Control Technician (RCT) first checking the item for radioactivity. However, non-activated items that you bring into an area posted "Activation Check" may be removed without an activation check if you know that the item could not have been exposed to beam or have become activated in any other way. If you did not bring the item into the area, however, and you want to bring it out, then you must have it checked for activation; e.g., tools you may find.

Many small radioactive parts that came from a larger assembled item may be inside a Radioactive Material Area and these small parts might not be tagged, even though the original assembled item may have been tagged. These smaller parts must be checked and released/tagged by an RCT.

Any shipments of radioactive material off-site must be checked in order to ensure proper packaging and labeling. Off-site shipping of radioactive materials must be coordinated with the BNL Isotopes & Special Materials (I&SM) Group.

RADIATION SOURCES

Beta, gamma and neutron sources produce radiation levels that may travel many feet in air. The radiation level drops rapidly as the inverse square of distance. This is because most sources are point-like objects. Sources are stored in shielded containers.

If you are using a source in your work, then the following rules apply (even if you obtained the source from another on-site BNL Department or Division):

- Contact the C-AD Source Custodian to have a source registered in the C-AD inventory.
- Have all sources inventoried and leak-checked every six months by the C-AD Health Physics Office.
- Complete the sealed-source inventory form and keep it with the source at all times.
- Notify BNL Isotopes & Special Materials Group prior to shipping a source to or from BNL.
- Contact the C-AD Source Custodian if you are going to remove a source from the C-AD facility.

If you are responsible for a sealed source, then DOE Orders and Federal Law require you to keep track of it in a way that can be audited by the Federal government. Additionally, you must be a trained and qualified "Source Custodian." Contact the C-AD Source Custodian for training.

Federal rules define sealed sources as any radioactive item manufactured for the sole purpose of using the emitted radiation. A common example of a sealed source is an instrument calibration source. The following are not sealed sources: smoke detectors, exit signs, activated beam-line components, activated shields, radioactive materials in-process such as targets or cooling waters, and keep-alive sources inside instruments.

If you are not sure about the rules or definition of a sealed source, then contact the C-AD Source Custodian.

CHIPMUNKS AND RADIATION SURVEYS

Radiation monitors - Chipmunks

During a running period, radiation surveys are updated periodically, and continuous area monitoring is performed by instruments called Chipmunks. Most of these instruments alarm in the Main Control Room. During shutdowns, surveys are done initially, and whenever a job-specific RWP (Radiation Work Permit) is used, or when deemed necessary or appropriate by the C-AD Health Physics Group. Records of the surveys are maintained by the C-AD Health Physics Group. Survey data is normally attached to the permits and copies are maintained at the job site.

Chipmunk readings are also recorded continuously and maintained in a database for later retrieval and review. In addition to alarming in the Main Control Room, Chipmunks are capable of alarming locally and are stationed at fixed locations in order to monitor high occupancy areas and other areas of interest.

Retrospective exposure rates for any area of interest can be determined by the staff at the C-AD Health Physics Office.

The Chipmunk is set up like a street light with red, yellow and green indicators. A chipmunk will display a red blinking light for radiation levels greater than 20 mrem/h, and a yellow blinking light for levels approximately 2.5 to 20 mrem/hr. Normally, chipmunks operate in the green range indicating nominal radiation levels. If you observe a chipmunk indicating in the yellow or red range, leave the immediate area, notify your collaborators to leave the immediate area, and then contact the Main Control Room (x4662) for instructions. Notify them of your Chipmunk location if you know it (Chipmunks locations are numbered locally). Note: In some cases, when running high-energy proton beam for example, it may be expected that a chipmunk will be indicating slightly in to the yellow near a target room at some locations of the Collider-Accelerator complex.

There are over 100 chipmunk-monitoring devices in use at this time. They have pre-designated alarm levels established by the Radiation Safety Committee. Main Control Room Operators are trained to respond to alarms and investigate the cause, even if it means interrupting the physics program. Do not move or tamper with chipmunks.

RADIATION SAFETY SERVICES

C-AD Health Physics Office x4660

The Radiological Control Division provides the C-AD with services that encompass several operational aspects of safety including radiation safety. They provide dose records, radiation surveys, Radiological Control Technician (RCT) coverage for high-dose jobs and experiment runs, and review of RWPs for ALARA. They also assist in re-setting secondary beam lines, and assist in interpreting abnormal radiation levels.

During running periods, RCT coverage is provided on all shifts. During shutdown, services are provided from 8:30 a.m. to 4:30 p.m., Monday through Friday. Assistance is obtained by contacting the C-AD Health Physics Office (x4660). If HP personnel are not available at x4660 and you need immediate assistance, you may contact the C-AD Main Control Room (x4662) and MCR can then contact an RCT by radio.

Special shifts for RCTs may be pre-assigned allowing for specific round-the-clock coverage when needed during a shutdown. A few weeks advance notice should be given to the Radiological Control Division Representative for special RCT coverage.

FLASHLIGHTS IN PRIMARY AREAS

Based on experience, when power failures occur primary areas can become dark or poorly lighted even with emergency lighting. It has become standard practice to take a flashlight with you when you work in primary areas, particularly when working in the AGS, Booster or RHIC tunnels.

PRIMARY AREAS - - ENTRY and EXIT

Access Control System
and
Particle Accelerator Safety System (PASS)

Access to Primary Areas is controlled by either the Access Control System or the Particle Accelerator Safety System (PASS), depending on the area of the C-AD complex. Access is through locked gates that require a key for entry such as a "0" Key, "256" Key or Card Key.

The Access Control System and Particle Accelerator Safety System (PASS) are the major design features used for your radiation protection. They incorporate the locked gates used to enter and exit the C-AD Primary Areas where radiation levels are to be considered lethal with beam on. They detect excessive radiation levels outside shielded areas via radiation monitors (chipmunks) and will shut off the beam if chipmunk set points are reached.

PASS also provides protection for oxygen deficiency hazards (ODH). PASS detects ODH conditions and sets off alarms, turns on ventilation equipment and secures some electrical equipment.

- The Access Control System and the Particle Accelerator Safety System (PASS) were designed to protect personnel from:
    - radiation hazards (Access Control System & PASS), and
    - oxygen deficiency hazards (PASS).

The systems, or any individual gate or gates, can be in any one of 3 modes:

Access Prohibited Mode

Controlled Access Mode

Restricted Access Mode

During ACCESS PROHIBITED mode, access is not allowed. This mode means that either beam is on or is set to be turned on (beam is "enabled"). With beam on, radiation hazards in primary areas should be considered lethal, therefore access is prohibited. During this mode, a locking mechanism similar to a deadbolt is kept in place and your "0" Key, "256" Key or Card Key will not work. If you force a gate open, sensors will detect the door's open position and cause at least two critical devices (such as beam stops, steering magnets) to intercept the beam before a person can penetrate the area to any significant degree.

During RESTRICTED ACCESS mode, you may enter and exit the primary area at will using your "0" Key, "256" Key or Card Key. During this mode, beam is off and the Main Control Room is not set to turn beam on. You are not being tracked (or accounted-for) during this mode. That is, no one is making sure that who goes in, comes out. You may go in to the primary area through one gate, and come out another gate. You do not have to enter and exit the same gate. During this mode, most electrical systems in the primary area are turned off, many are locked-out and tagged-out (LOTO'd).

During CONTROLLED ACCESS mode, personnel are being tracked (or accounted-for). There is a "gate watch" that is verifying that each person who enters the primary area also exits the primary area. The gate watch can take different forms. It can be a MCR Operator located at the gate logging in and out each person - - you may be required to sign in and out on a gate watch log, you may also be asked to leave your BNL ID badge upon entry, which will be returned upon exit. Or, access may be controlled remotely by MCR such as with the Key Tree and camera system used for access through the gates that lead to the Intersection Regions of the RHIC experiments (STAR, PHENIX, BRAHMS) and to the NSRL target room. During Controlled Access mode you must enter and exit the same gate and be accounted-for. During this mode, most electrical systems are turned on and beam is more ready (not "enabled" however) to be turned on than in Restricted Access mode.

During Controlled Access mode, entry AND exit from the primary area is coordinated with the C-AD Main Control Room (MCR).

- If you are not sure of the procedure for entering AND exiting a primary area during Controlled Access mode, contact the C-AD Main Control Room or prior to entry.

- If you are not sure of the access control mode that a primary area gate is in, contact the C-AD Main Control Room prior to entry.

At RHIC, the typical gate to a primary area has PASS control boxes with lights that tell you what access control mode the gate is in:

PASS Control Boxes

RED light: Prohibited Access mode
YELLOW light: Controlled Access mode
GREEN light: Restricted Access mode

The above type PASS control boxes are located at RHIC and at NASA Space Radiation Lab (NSRL) primary area gates. During Restricted Access mode, an access card-key is used for entry at these gates.

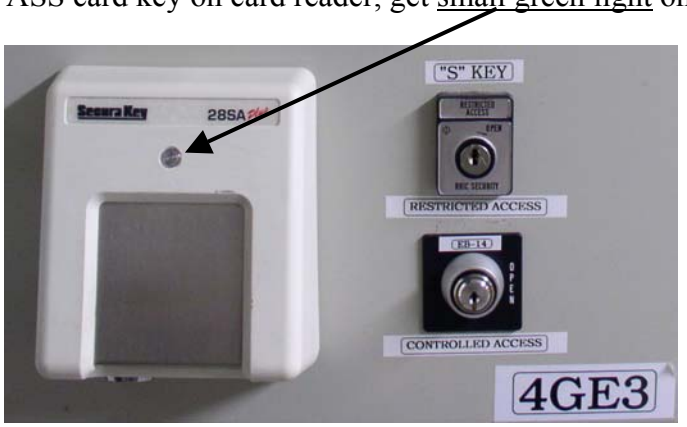
Card Key

Card Keys can be:

Blue - for employees
Pink - for RHIC Users
Orange - for NSRL Users

During Restricted Access mode:

To enter, place the PASS card key on card reader, get small green light on reader, open door.



To exit, turn knob to open door and exit (key not required to exit).

At gates where PASS control boxes are not used, a "256" Key or "0" Key is used for entry during Restricted Access mode. Examples are: AGS tunnel, Booster tunnel, Bldg 912 target caves.

- Unescorted entry into primary areas requires that each individual be current in the required training (facility-specific training AND Radiation Worker Training as a minimum) and have their own key; 0-Key, 256-Key, RHIC, NSRL or Blue Card Key
- Unless proper escort paperwork is completed and approved, an untrained person entering under someone else's key (or tailgating) is considered a serious violation of procedure and is subject to disciplinary action.

Never lend your 256-Key, 0-Key or card key to others. For 0-Keys, 256-Keys, RHIC, NSRL or Blue Card Keys, contact the C-AD Training Office, Bldg 911, Room A-128, x7007.

How is it assured that no persons are left inside a primary area before beam is enabled?

NOTE: Radiation dose inside primary areas should be considered **lethal** with beam on!

During Restricted Access mode, trained individuals come and go from the primary areas essentially at-will. In going from "Restricted Access" mode to "Controlled Access" mode, the C-AD Main Control Room (MCR) must assure that all personnel have exited the primary areas. Then, once it is assured that all individuals have exited, and once in Controlled Access mode, a "gate watch" verifies that anyone then entering through a primary area gate also exits the area through that same gate (individuals are being tracked or accounted-for).

So, how is it assured that the primary areas are cleared of personnel (that all personnel have exited) when going to Controlled Access mode?

Part of the answer is that an audible announcement is made stating that the primary areas are going into Controlled Access mode and that all personnel should exit. However, the essential (most reliable) action taken to assure the areas are cleared of personnel is that a "sweep" is performed. Trained personnel physically walk-down the primary areas where beam is to travel and look for any people who may still be in the primary areas. This visual inspection can take several hours, depending on the areas to be swept and depending on how many staff personnel are assigned to conduct the sweeps. Approved procedures and detailed checklists are used to assure that all required areas have been checked.

First entry into a Primary Area after beam is turned off:

The first entry into a primary area after beam has been turned off is made by a Radiological Control Technician (RCT) to perform a radiation survey. This is to assure that appropriate decay time has been allowed to pass before other personnel are allowed access. Contact MCR before first entry. There are exceptions where operating experience shows no significant residual radiation. If in doubt, then contact MCR before entry.

ENTERING CONTAMINATION AREAS or HIGH RADIATION AREAS

Entering a Contamination Area (or High Contamination Area) or High Radiation Area requires that you sign-in and sign-out on a Radiation Work Permit (RWP) written for that area. This is done by signing in and signing out on the "**C-AD RWP Access Control Log**" for that area.

Note: The "**RWP Access Control Log**" is NOT the same as the Main Control Room (MCR) "gate watch" log that keeps track of people going in and out of a primary area during "Controlled Access" mode. The "RWP Access Control Log" is NOT used to keep track of people inside primary areas.

Note: This Contamination/High Radiation Area RWP is NOT the same as the C-AD Standing/General RWP for entering "Radiation Areas".

Information that the Contamination/High Rad Area RWP log requires you to complete or verify:

I am qualified in C-AD Access training (sign your initials to confirm)
I will wear my TLD AND a Digital Alarming SRD (sign your initials to confirm)
I have reviewed my estimated Dose Limits indicated on the RWP (sign your initials to confirm)
Print Name
Signature
Individual Under Escort (indicate Yes or No)
Life Number
Date
Time In
Time Out
Dosimeter Number (this is your Self Reading Dosimeter number)
SRD Calibration Due Date (to assure you always use an SRD within calibration)
SRD Reading Pre
SRD Reading Post
Net-SRD Reading

A corresponding EWP (Enhanced Work Permit) is also with the RWP log. When signing-in on the log, you are signing-in for both the RWP and the EWP.

The C-AD RWP Access Control Logs are located at entrances to High Radiation Areas and Contamination Areas. The logs are collected periodically and reviewed. The SRD data is reviewed. Make sure you enter ALL your exposure for the day onto the log. The C-AD ESHQ Division will notify your supervisor if you are approaching a C-AD Administrative Control Level (ACL), **although it is also your own responsibility to be aware of your own dose and the ACLs**.

The sign-in log must be completed once for each job or once each day for multi-day jobs as a minimum – **NO EXCEPTIONS**. There should be NO BLANKS after signing out; all information must be entered.

Signing-in indicates that you have read, understood and will comply with the RWP and EWP prior to initial entry to the area and after any revisions.

If the Self Reading Dosimeter (SRD) calibration due date has passed, DO NOT ENTER THE POSTED AREA. Obtain a new dosimeter that is within the calibration due date. The C-AD Training Office and C-AD Health Physics Office can issue SRDs.

CAUTION: Changes in job scope or in radiological conditions will void the RWP. Consult the C-AD Radiological Control Division Representative for direction.

- To enter a Contamination Area (or High Contamination Area) or High Radiation Area you must:

- Properly and completely sign-in and sign-out on the "C-AD RWP Access Control Log" for the area
- Wear your TLD
- Wear a Digital Alarming Self Reading Dosimeter (SRD)
- Be trained/qualified for the area

The RWP sign-in log provides Radiation Workers or Contamination Workers with an opportunity before entering the area to review requirements for entering or working in the area.

The RWP specifies such things as dose limits, any protective equipment or clothing requirements, dosimetry requirements, training requirements and Facility Support coverage requirements.

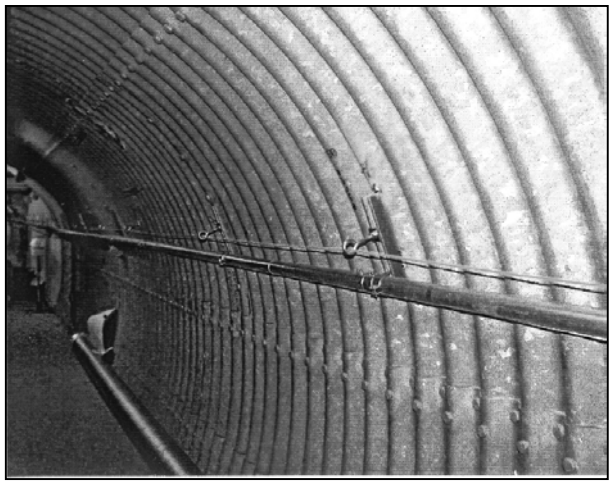
At C-AD, Contamination Areas (or High Contamination Areas) and High Radiation Areas are also usually Primary Areas. Therefore, if the area is also under "Controlled Access" mode, you must comply with the MCR "gate watch" requirements in addition to signing-in and out on the RWP log.

Within posted High Radiation Areas, higher radiation spots from 100's to 1000's of mrem/hour may exist along the beam lines ("Hot Spots").

BEAM IMMINENT

CRASH BUTTONS
CRASH CORDS

Crash Button Located in AGS Ring



Crash Cord Located in U-Line

Crash Cord Located in RHIC Tunnel

If procedures are followed, there should not be a case where an individual is mistakenly left inside a Primary Area when beam becomes enabled or is “imminent”. However, the C-AD complex is set up to warn personnel should this occur.

Beam-Imminent Warning Signals:

In the RHIC tunnel and in RHIC experimental areas prior to beam an orange strobe will illuminate the area and an audible alarm sounds for 90 seconds. At other primary areas throughout the C-AD complex, overhead lights go dim or go out, and there is an audible announcement and/or an audible alarm.

What action do you take if you see or hear a beam-imminent warning signal and you are in a Primary Area?

- Push a Crash Button or Pull a Crash Cord, or exit the area immediately through an access gate
- Notify the C-AD Main Control Room after you have exited

If you are near an exit gate, simply push open the gate using the crash bar on the gate and exit the area. You do not have to go search for a crash button or crash cord. Exiting through a gate using the crash bar in Prohibited or Controlled Access mode will "CRASH" (prevent) the beam the same as pushing a crash button or pulling a crash cord.

Crash buttons are red and mushroom shaped and labeled with a red sign.

Doors have crash bars.

Orange crash cords are mounted on the walls of the RHIC tunnel, RHIC experimental areas, NSRL tunnel (beam line from Booster), AGS to RHIC transfer line (AtR), U-Line and other transfer lines.

Crash buttons are located at AGS, LINAC and Booster, at several locations in the muon storage ring area (g-2) of Building 919, and along other primary beam lines. There are also crash buttons located in secondary beam lines as well as target rooms.

If you see a visual warning or hear an audible warning, start for the nearest crash button or crash cord, or start for the exit.

If the lights go out or go dim, do not assume it is a power failure, assume beam is imminent.

DO NOT PANIC, you have time, 30 seconds minimum.

Pushing crash buttons or opening doors will turn lights on.

Pushing crash buttons causes beam stops to insert, lights to go on, and interrupts electrical energy to the main magnet bus and RF devices. Pulling a crash cord causes beam stops to be inserted. One can always "crash" out of any primary area through an Access Control System or Particle Accelerator Safety System (PASS) gate by pushing the gate's crash bar.

Keys are not needed to exit.

DO NOT ALTER crash cords, crash buttons or crash bars. Do not hang tools or clothing on the crash cords. This may stretch them out causing reset errors. Any modification to the Access Control System or Particle Accelerator Safety System (PASS) (such as to the entry/exit gates) must be pre-approved by the C-AD Access Controls Group.

POWER FAILURE DURING ACCESS PROHIBITED MODE

During a power failure, the Access Control System or the Particle Accelerator Safety System (PASS) may drop to Controlled or Restricted Access Mode if the battery back-up system also fails. Since there may be high levels of residual radiation in primary areas, DO NOT attempt to enter primary areas with your 256- or 0-key immediately following a power failure since RCTs would not have had the opportunity to do a survey. CONTACT the Main Control Room first.

INTERLOCK BYPASS

- Do not take it upon yourself to bypass any system interlock

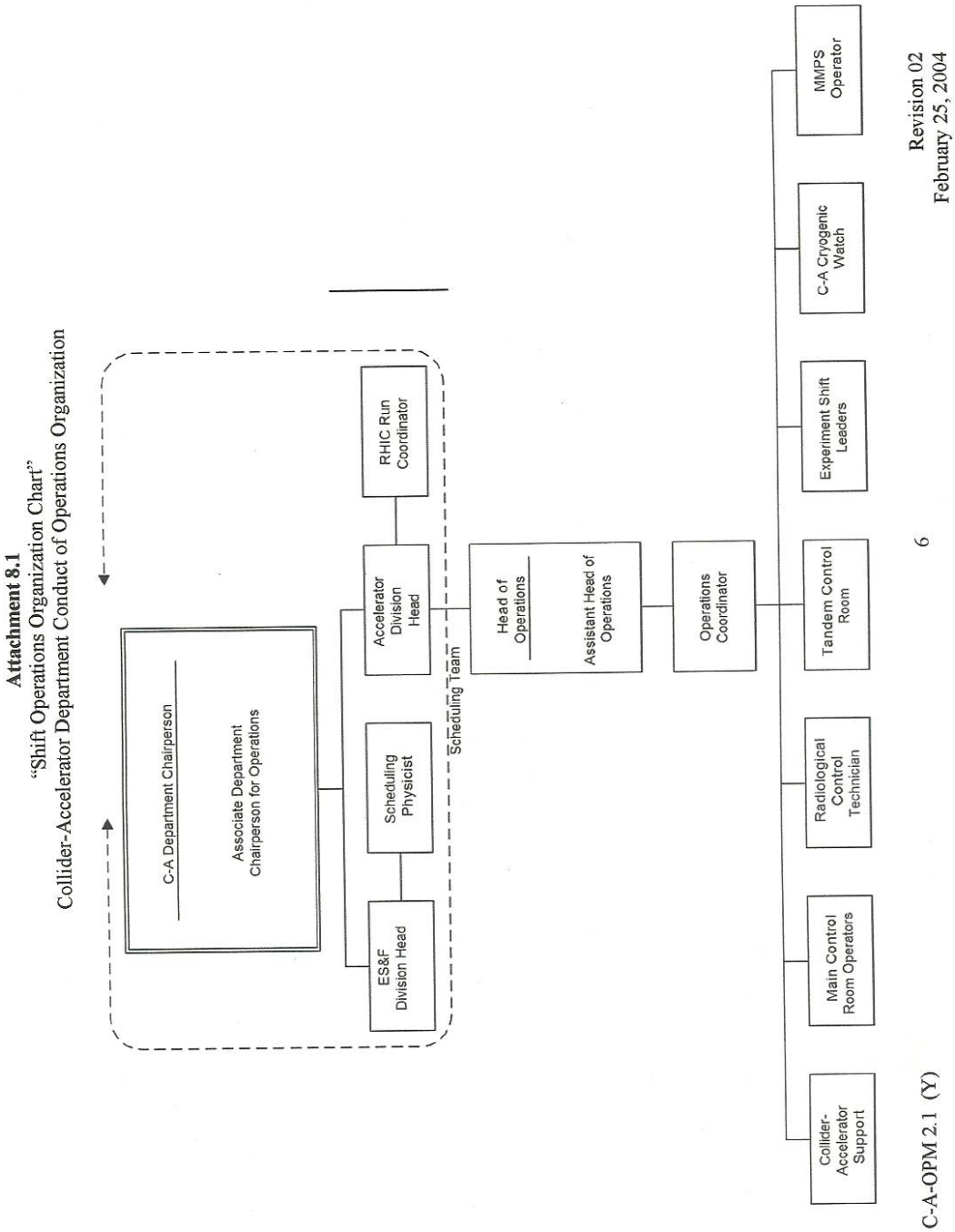
Interlock bypassing can only be done at the discretion of the C-AD Radiation Safety Committee. Proper authorizations must be obtained prior to the bypass. The protection offered in lieu of the interlock must be equivalent. You can meet this requirement by having the liaison physicist and the Radiation Safety Committee Chair review and approve the bypass.

WHO IS MOST RESPONSIBLE FOR YOUR SAFETY?

- You are the person most responsible for your safety. Use common sense. Never assume you know all the hazards.

- When in doubt, consult an expert. Contacts include the C-AD ESH Coordinator, ESHQ Division, MCR, Health Physics Office, various safety committees, liaison engineers, liaison physicists, project engineers.

Attachment 8.1
"Shift Operations Organization Chart"
Collider-Accelerator Department Conduct of Operations Organization



Revision 02
February 25, 2004

C-A-OPM 2.1 (Y)

6

DOE Orders on the conduct of operations of accelerator facilities require that C-AD follow guidelines that require:

- Written procedures for most operations
- Use of qualified and trained personnel
- Appropriate authorizations and work permits before starting work or operations
- Definitive lines of authority

During operating periods, responsibility for the safe and reliable operation of the Collider-Accelerator complex resides with the on-duty Operations Coordinator (OC). The Operations Coordinator is the shift supervisor for the operating personnel and the focus for all operations related questions. You may contact the OC if you have a problem or need assistance. The OC can make appropriate follow up notifications and arrange for assistance. The OC is located at the C-AD Main Control Room in building 911 (x4662).

During maintenance or shutdown periods, all operational related maintenance is scheduled and coordinated through the C-AD Maintenance Coordinator.

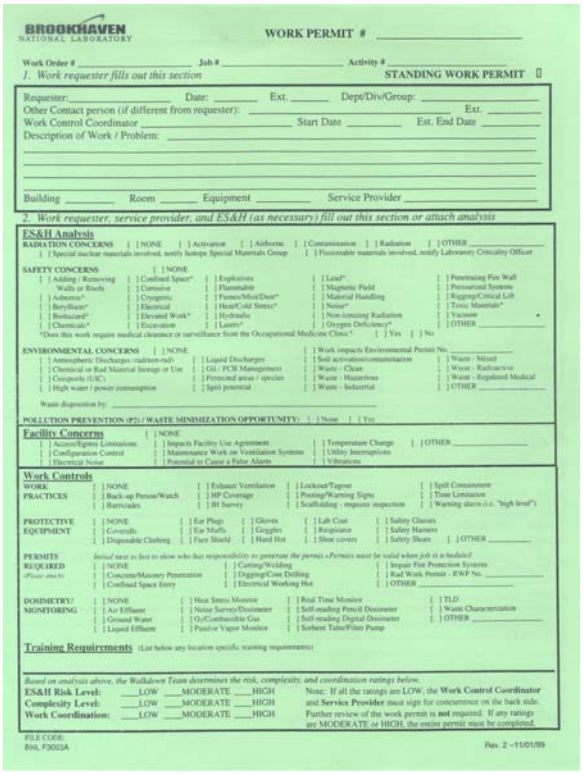
You can determine if the facility is operational or shutdown by reading this information from TV monitors located throughout the C-AD Complex.

All work must be done by trained/qualified personnel and with appropriate work permits and authorizations.

All C-AD operations must have the appropriate authorization. Required authorizations are listed in the C-AD Operations Procedure Manual (OPM). Lead-personnel are appropriately trained. If requested, you must satisfy C-AD requirements for authorization (e.g., for working on a system declared as “critical”).

WORK PLANNING & SCREENING

Work Permit (green form)



BROOKHAVEN NATIONAL LABORATORY

WORK PERMIT # _____

Work Order # _____ Job # _____ Activity # _____

1. Work requester fills out this section STANDING WORK PERMIT ☐

Requester: _____ Date: _____ Ext. _____ Dept/Div/Group: _____

Other Contact person (if different from requester): _____ Ext. _____

Work Control Coordinator _____ Start Date _____ Est. End Date _____

Description of Work / Problem: _____

Building _____ Room _____ Equipment _____ Service Provider _____

2. Work requester, service provider, and ES&H (as necessary) fill out this section or attach analysis

ES&H Analysis

RADIATION CONCERNS [ ] NONE [ ] Activation [ ] Airborne [ ] Contamination [ ] Radiation [ ] OTHER _____

[ ] Special nuclear materials involved, notify Isotope Special Materials Group [ ] Fissionable materials involved, notify Laboratory Criticality Officer

SAFETY CONCERNS [ ] NONE

[ ] Adding / Removing Walls or Roofs [ ] Confined Space* [ ] Explosives [ ] Lead* [ ] Penetrating Fire Wall
[ ] Asbestos* [ ] Corrosive [ ] Flammable [ ] Magnetic Field [ ] Pressurized Systems
[ ] Beryllium* [ ] Cryogenic [ ] Fumes/Mist/Dust* [ ] Material Handling [ ] Rigging/Critical Lift
[ ] Biohazard* [ ] Electrical [ ] Heat/Cold Stress* [ ] Noise* [ ] Toxic Materials*
[ ] Chemicals* [ ] Elevated Work* [ ] Hydraulic [ ] Non-ionizing Radiation [ ] Vacuum
[ ] Excavation [ ] Lasers* [ ] Oxygen Deficiency* [ ] OTHER _____

"Does this work require medical clearance or surveillance from the Occupational Medicine Clinic? [ ] Yes [ ] No

ENVIRONMENTAL CONCERNS [ ] NONE [ ] Work impacts Environmental Permit No. _____

[ ] Atmospheric Discharges (radium-rad) [ ] Liquid Discharges [ ] Soil activation/contamination [ ] Waste - Mixed
[ ] Chemical or Rad Material Storage or Use [ ] Oil / PCB Management [ ] Waste - Clean [ ] Waste - Radioactive
[ ] Cesspools (UIC) [ ] Protected areas / species [ ] Waste - Hazardous [ ] Waste - Regulated Medical
[ ] High water / power consumption [ ] Spill potential [ ] Waste - Industrial [ ] OTHER _____

Waste disposition by: _____

POLLUTION PREVENTION (P2) / WASTE MINIMIZATION OPPORTUNITY: [ ] None [ ] Yes

Facility Concerns [ ] NONE

[ ] Access/Egress Limitations [ ] Impacts Facility Use Agreement [ ] Temperature Change [ ] OTHER _____
[ ] Configuration Control [ ] Maintenance Work on Ventilation Systems [ ] Utility Interruptions
[ ] Electrical Noise [ ] Potential to Cause a False Alarm [ ] Vibrations

Work Controls

WORK PRACTICES [ ] NONE [ ] Exhaust Ventilation [ ] Lockout/Tagout [ ] Spill Containment
[ ] Back-up Person/Watch [ ] HP Coverage [ ] Posting/Warning Signs [ ] Time Limitation
[ ] Barricades [ ] IH Survey [ ] Scaffolding - requires inspection [ ] Warning alarm (i.e. "high level")

PROTECTIVE EQUIPMENT [ ] NONE [ ] Ear Plugs [ ] Gloves [ ] Lab Coat [ ] Safety Glasses
[ ] Coveralls [ ] Ear Muffs [ ] Goggles [ ] Respirator [ ] Safety Harness
[ ] Disposable Clothing [ ] Face Shield [ ] Hard Hat [ ] Shoe covers [ ] Safety Shoes [ ] OTHER _____

PERMITS REQUIRED *(Please check)* *Initial next to box to show who has responsibility to generate the permit.* *Permits must be valid when job is scheduled.*

[ ] NONE [ ] Cutting/Welding [ ] Impair Fire Protection Systems
[ ] Concrete/Masonry Penetration [ ] Digging/Core Drilling [ ] Rad Work Permit - RWP No. _____
[ ] Confined Space Entry [ ] Electrical Working Hot [ ] OTHER _____

DOSIMETRY/ MONITORING [ ] NONE [ ] Heat Stress Monitor [ ] Real Time Monitor [ ] TLD
[ ] Air Effluent [ ] Noise Survey/Dosimeter [ ] Self-reading Pencil Dosimeter [ ] Waste Characterization
[ ] Ground Water [ ] O_2/Combustible Gas [ ] Self-reading Digital Dosimeter [ ] OTHER _____
[ ] Liquid Effluent [ ] Passive Vapor Monitor [ ] Sorbent Tube/Filter Pump

Training Requirements (List below any location specific training requirements)

Based on analysis above, the Walkdown Team determines the risk, complexity, and coordination ratings below.

ES&H Risk Level: ___LOW ___MODERATE ___HIGH
Complexity Level: ___LOW ___MODERATE ___HIGH
Work Coordination: ___LOW ___MODERATE ___HIGH

Note: If all the ratings are LOW, the **Work Control Coordinator** and **Service Provider** must sign for concurrence on the back side. Further review of the work permit is **not** required. If any ratings are MODERATE or HIGH, the entire permit must be completed.

FILE CODE: Bld. F3053A

Rev. 2 – 11/01/99

All work at C-AD must be screened for environment, safety and health (ES&H) hazards. All work must be done by trained/qualified personnel and with appropriate work permits and authorizations.

Be aware that work policies and practices at C-AD may be more restrictive than elsewhere at the Lab so you must always follow proper C-AD work planning procedures. For example, training requirements and PPE requirements may be more restrictive in certain cases at C-AD, use of wooden ladders is not permitted at C-AD, clean-up policy at C-AD may be different than at other areas of the Lab (at C-AD, Building Managers must request garbage pickup for service buildings that are not occupied full time, or staff must bring back trash from the building after they perform a service).

A Work Control Coordinator determines if the work is "Low", "Moderate" or "High" Hazard. The Work Permit (green form) may be used as a screening tool to make this determination, however the Work Permit (green form) is <u>required</u> for all Moderate and High Hazard jobs.

Procedures are also established to perform routine or repeat type work or maintenance where hazards are known from experience and are addressed by the procedure. A procedure may also be written for non-routine complex work.

The hazard levels are briefly described below.

> Low-Hazard Work is work requiring the attention of the worker to prevent minor injury. Failure to correctly perform low-hazard work would not damage equipment or structures or release potentially hazardous materials to the environment, except as a result of gross negligence.
>
> Moderate-Hazard Work: Work requiring coordinated actions to prevent any injury to personnel, minor damage to equipment or structures, or release of hazardous materials to the on-site environment.
>
> High-Hazard Work: Work requiring coordinated actions to prevent serious injury to personnel, significant damage to equipment or structures, or releases of reportable quantities of potentially hazardous materials to the off-site environment.

C-AD Work Control Coordinators complete additional training on work planning. Additional details and specific requirements for work planning at C-AD are found in C-AD Operations Procedures Manual (OPM) Procedure 2.28, "C-A Procedure for Work Planning and Control for Operations". It is a supervisor's responsibility to ensure that all work is planned in accordance with the intent of C-AD procedures.

Whether you are a BNL or C-AD employee or not, if you are ever in doubt about the work control requirements for a job that you are responsible for or are involved with, contact the C-AD Work Control Manager.

STOP WORK POLICY

IMMINENT DANGER

This policy allows an individual to stop work at BNL to mitigate *imminent danger* to personnel, equipment or the environment.

Imminent danger exists when there is a hazard that could result in death, serious injury, environmental impairment or significant damage, and when immediate action is required. The person issuing the stop-work order makes this determination. Any knowledgeable person has the authority to issue a stop-work order at BNL. At C-AD, a knowledgeable person includes anyone having unescorted access to the complex.

ALL workers at BNL are required to be trained in the Lab's STOP WORK Policy. Stop Work training is included in the following Lab courses. For most individuals (employees, guests, contractors, vendors) Stop Work training is received by completing one of these courses:

- General Employee Training
- Annual Employee Refresher Training
- Guest Site Orientation
- Contractor/Vendor Orientation

Stop Work training can also be taken separately via a BNL web-based course located at the BNL Training Homepage.

Persons are responsible for and expected to issue a Stop-Work order for *imminent danger* whenever it is observed.

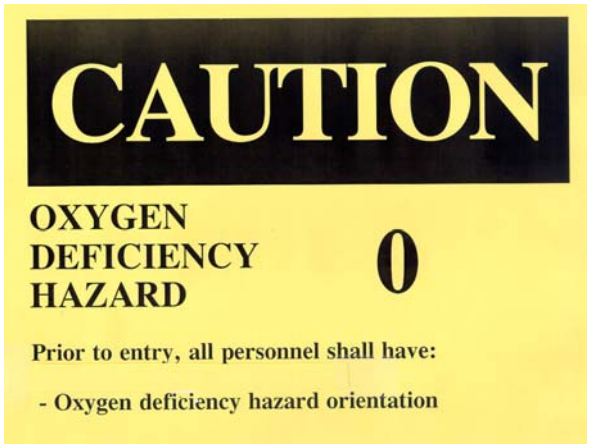
For non-imminent danger situations Management still expects that personnel call attention to any questionable or unsafe act or condition. Management takes such notification seriously and will respond.

OZONE

An ozone generator has been installed in the Pump Room located in building 957 as part of the cooling water purification system. This system incorporates many safeguards to provide a safe working environment for personnel. Inclusive of these safeguards is a monitor alarm system incorporating a yellow strobe light on top of the ozone panel. An additional strobe is located on the electrical rack for the pump control on the second floor. If the monitor detects ozone leaking from the generator system into the building air, due to multiple failures of safety backup systems, this will trigger the yellow strobe light indicating that you should leave the building immediately through the nearest exit and contact the C-AD Main Control Room.

Very low levels of ozone will irritate the eyes and throat giving you an indication of its presence. The effects are temporary. If you experience any of these symptoms in this building, even without a monitor alarm (yellow strobe light), leave immediately and contact the MCR. Each door to the Pump Room in building 957 is posted with this information.

OXYGEN DEFICIENCY HAZARDS



What is oxygen deficiency?

Air normally contains 20.9% oxygen, 78% nitrogen, and 1% argon. Oxygen deficiency is defined as less than 19.5 % oxygen. This happens when air in an enclosed space is displaced by another gas.

What causes oxygen deficiency?

At C-AD, cryogenic systems use large amounts of helium and nitrogen. Both liquids expand about 700-800 times when released into air. This could happen quickly with a major release such as a from a catastrophic failure. In a major release, one might see a rapidly expanding white cloud and hear a "whooshing " sound. The leak could also be slow, invisible and silent. Both helium and nitrogen are colorless and odorless.

Other causes of oxygen deficiency are use of compressed gasses, combustion, welding and use of fire suppressants. All of these in a confined space or area of low ventilation are significant concerns.

Sulfur hexafluoride (SF_6) is a noncombustible, colorless gas, with a slight sulfur like odor. This gas, which is heavier than air, is used at the Tandem Van de Graff as an insulating gas. An oxygen deficiency hazard may occur in the event of a large release of this material. Since this material is heavier than air, some low laying areas, basements and pits have been designated as an ODH Class 0 Area.

Carbon Dioxide (CO_2), used to extinguish fires, is an odorless, colorless gas, which also displaces oxygen when released. Building L18 at the AGS uses an automatic CO_2 fire extinguishing system for equipment protection. The system contains enough CO_2 to cause a serious oxygen deficiency if the CO_2 were released. If you need to enter Bldg L18, you will require special training and a CO_2 system bypass key. First consult with your supervisor then contact the C-AD Training Manager if you require access to the building.

The following table summarizes the health effects of oxygen deficiency.

Volume % O2	Effect on a Healthy Person	Approximate Time
17	Deep Breathing Faster Heartbeat	Rapidly
16	Dizziness, Slower Reaction Time	Rapidly
15	Impaired Attention And Coordination, Intermittent Breathing, Rapid Fatigue, Loss Of Muscle Control	Rapidly
12	Very Faulty Judgment, Inability To Move, Loss Of Consciousness, Brain Damage	10 Min 10 Min 2 Hours
10	Inability To Move, Nausea, Vomiting, Loss Of Consciousness	4 Min 10 Min
6	Loss of Consciousness Coma Death	30 sec 1 min 5 min

Effects can become permanent if exposure is not terminated quickly. The major effects hindering escape are disorientation and unconsciousness.

Classification Levels of Oxygen Deficiency Hazard (ODH)

There are five classes of ODH: 0 through 4, with 0 being the least hazardous. Each classification requires controls and posting commensurate with the hazard. Classification is based on the likelihood of fatality and the probability of occurrence. There are no areas at BNL with classification greater than Class 1. The RHIC refrigerator building, Bldg 1005R, is a Class 1 ODH Area. This training does NOT allow you unescorted access into Class 1 ODH Areas. Additional control measures and training are required for entry into a Class 1 ODH Area.

This C-AD Access Training allows you access to Class 0 ODH Areas at C-AD. These areas include:

• Buildings at RHIC with Valve Boxes:
  Support Buildings 1002B, 1004B, 1006B, 1008B
  Service Buildings 1010A and 1012A
• Collider Tunnel (the STAR and PHENIX Intersection Regions are not ODH areas)
• Helium Compressor Building 1005H
• Helium reliquifier section of Bldg 1005E
• AGS Tunnel if the Cold Snake is operating
• Tandem Van de Graaff (SF6)
• g -2 Compressor Building
• g-2 Muon Ring Storage Building (high bay)

When would you evacuate an ODH Area?

Any one or combination of the following requires an immediate evacuation of an ODH area:

- The in-place oxygen monitors set off an alarm:

  At the Collider complex, BLUE strobe lights and an audible alarm indicate an ODH event. Except, in building 1005H there is no audible alarm and a RED strobe indicates an ODH event.

- A vapor cloud is observed inside the ODH area or a loud "whooshing" sound is heard - - even if there is no audible alarm or strobe light activating. Note: There are no steam systems in the RHIC tunnel so a vapor cloud, although it may look like steam, should be assumed to be a cryogenic fluid leak, not a steam leak.

Evacuation procedure:

- If the hazard is helium (lighter than air) such as at RHIC:

  Stay Low.
  Duck under magnets to get to exits as opposed to climbing over magnets.
  Do not use overpasses to cross the beam lines.
  Do not use vertical (ladder) exits.
  Use only horizontal exits.

- If the hazard is sulfur hexafluoride (heavier than air) such as at the Tandem Van de Graff, do not exit through low areas. Leave low areas immediately.

- Leave the area immediately, moving away from any vapor cloud (can be lethal freezing hazard as well as ODH) or any noise (wooshing sound).

- If anyone is trapped, injured or feeling ill CALL x2222 or 911. You may pull a fire alarm box if one is in the area.

- DO NOT ATTEMPT A RESCUE as you are likely to be the next victim! Let the pros handle it.

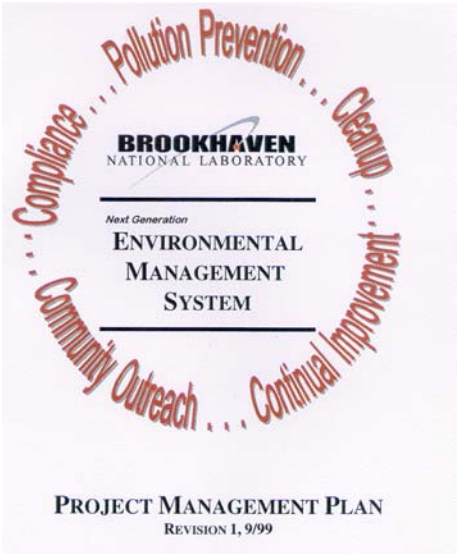
It is important to remember that you should not re-enter the area even with an ODH-1 escape pack. The escape pack is used for normal entry into an ODH Class 1 Area. They are for escape in case of an event, and NOT for entry for rescue. Let the Fire/Rescue Group handle it. ODH deaths usually come in pairs. More than 50% of ODH deaths are of would-be rescuers. One or two breaths could cause loss of consciousness.

ENVIRONMENT, SAFETY, SECURITY & HEALTH (ESSH) POLICY

BNL ESSH Policy Highlights

1. We are all responsible for safety
2. Consider the safety of others
3. Integrate ESSH into our research and operations
4. Comply with BNL ESSH requirements
5. Reduce risks, conserve resources and prevent pollution
6. Assist stakeholders with their ESSH needs
7. Participate in community and government initiatives

Environmental Management System (EMS):



EMS P2C4:

• **P**ollution **P**revention – Strive to prevent pollution, minimize wastes and conserve resources

• **C**ompliance - Comply with all applicable environmental requirements

• **C**leanup – Aggressively correct and clean up existing environmental problems

• **C**ontinual Improvement – Protect our ecosystem and community by continually improving the way we manage our programs

• **C**ommunity Outreach – Openly communicate our progress and performance to our community and stakeholders

International Standards:

OHSAS 18001 (Safety & Health)
ISO 14001 (Environment)

The Collider-Accelerator Department has achieved registration under the following ISO (International Standards Organization) Standards:

ISO 14001 (Environment)
OHSAS 18001 (Safety & Health)

The Laboratory and C-AD are periodically audited by the ISO audit team. In order to remain in "good standing" and continue to maintain ISO 14001 and 18001 registration, we must operate in accordance with the Lab's ESSH (Environment, Safety, Security & Health) Policy. C-A Department procedures and the Lab's SBMS help assure that we continue to meet the intent of the Lab ESSH Policy and the requirements under ISO 14001 & 18001.

Your responsibility: Be aware that the work you perform could have significant impact on the environment or on personnel safety and health. Below are examples of how your work might have such impact. These are just examples. Details of C-AD environment, safety & health issues associated with individual jobs, materials, work areas, experimental areas, processes, experiments and machine operations are also identified through mechanisms such as work planning, training, safety review committees, Job Risk Assessments, Facility Risk Assessments, OPM procedures, group procedures and Tier 1 Inspections.

Examples of environmental impacts:
Atmospheric discharges
Liquid discharges
Environmental noise
Hazardous waste
Radioactive waste
Mixed waste
PCBs
Regulated industrial waste
Regulated medical waste
Soil activation
Storage/use of chemicals or radioactive material
Electric power consumption to operate the complex
Water consumption to operate the complex
Radioactive materials storage
Hazardous or radioactive material spills

Examples of safety & health impacts:
Ionizing radiation
Non-ionizing radiation
Hazardous or toxic materials
Radioactive materials
Electrical energy
Explosive gases and liquids
Oxygen deficiency
Kinetic energy
Potential energy
Thermal energy
Cryogenic temperatures
Protracted/irregular hours
Natural hazards
Housekeeping hazards
Working environment hazards such as heat, cold, mold, dust
Ergonomics
Flammable or combustible materials

If you have questions about how your work at C-AD might impact the environment, safety, security or health, there are several C-AD contacts that you may call upon:

Associate Chair for ESHQ
Head of ESHQ Division
Environmental Coordinator
Environmental Compliance Representative
ESH Coordinator
Radiological Control Division Representative

Environmental, Safety, Security, and Health Policy

This policy is consistent with BNL's research interests, ethics, and shared values. We commit to continual improvement in environmental, safety, security, and health (ESSH) performance. We will set goals, measure progress, and communicate results. Compliance with this policy is the responsibility of every employee, contractor, and guest. Specifically, we commit to the following:

- **Employees, Contractors and Guests:** We will provide a safe and healthy workplace, striving to prevent injuries and illnesses, promoting healthy lifestyles, and encouraging respect for the environment. We will ensure our employees, contractors, and guests have the awareness, skills, and knowledge to carry out this policy.
- **Compliance:** We will meet all applicable ESSH laws and BNL Standards Based Management System, Integrated Safety Management, and Integrated Safeguards and Security Management requirements.
- **Integration:** We will integrate ESSH principles into our research and operations activities. We will integrate hazard prevention/reduction, pollution prevention/waste minimization, resource conservation, security, and compliance into all of our planning and decision-making. We will adopt cost-effective practices that eliminate, minimize, or mitigate environmental impacts and control safety, security, and health risks and vulnerabilities.
- **Security:** We will work in compliance with DOE's ISSM Program and systematically integrate safeguards and security into management and work practices at all levels, so that the laboratory missions are accomplished in a safe and secure manner.
- **Sustainable Development:** We will strive to conserve resources and minimize or eliminate adverse ESH effects and risks that may be associated with our research and operations. We will manage our programs in a manner that protects the ecosystem and employee/public health.
- **Stakeholders:** We will work with our stakeholders to help them address their ESSH needs. We will maintain a positive, proactive, and constructive relationship with our neighbors in the community, regulators, DOE, and our other stakeholders. We will openly communicate with stakeholders on our progress and performance.
- **Community and Government:** We will participate in community and government ESSH initiatives. We will define, prioritize, and aggressively prevent, correct, and/or clean up existing environmental, security, and occupational safety and health problems.

Last Modified: May 4, 2006 (http://www.bnl.gov/ESHQ/ESSH.asp)

SPILLS

The C-A Department is required to report spills internally, externally (to external organizations such as NY State agencies, DOE) or BOTH.

C-AD must report ***quickly*** to external agencies on spills that impact the environment. Even minor events, such as spilling any amount of oil in an outdoor area to soil or a waterway, require reporting. If you spill any hazardous or industrial material outdoors to soil or a waterway, or anywhere inside and the spill is beyond your control, call x2222 or 911 to report the spill. Then call: C-AD Main Control Room (x4662), the C-AD ESHQ Division Head (x5272) or the C-AD Environmental Coordinator (x7520).

When reporting, give your name and information on spill location, type of material and approximate amount (as best as you can).

Do not leave a message on an answering machine as notification.
The rules are such that we must *consider* reporting spills of any type or size.

When must a spill be reported by calling 911 or x2222?

- Unexpected releases of oil, hazardous substances, and radioactive materials known or suspected to have impacted the environment (including spill to the soil or a waterway, regardless of size of spill)
- Any hazardous material spill where your actions would result in exposures to chemicals above established safety limits
- Spills where you possess neither appropriate equipment nor training to mitigate the incident
- Airborne releases of hazardous materials or spills that are likely to result in an uncontrolled release of the hazardous material

When don't I have to call in a spill to 911 or x2222?

All of these must be met:

- The spill is onto an impermeable surface
- The material spilled is not highly toxic or highly volatile
- The person responding to the spill has appropriate training and materials to clean up the spill
- For petroleum based products, the volume of the spill is less than five gallons
- The spill is cleaned up immediately

The C-AD ESH Coordinator or C-AD Environmental Coordinator is to be contacted in the event of a spill to evaluate and coordinate the clean-up effort

REMOVING DAMAGED EQUIPMENT FROM SERVICE

If equipment is damaged and unsafe (such as broken ladders, frayed slings, defective power cords, leaking tanks), or is not permitted to be used at C-AD (such as wooden ladders), you must have it removed from service. If you are not sure of how to remove an item from service, contact your supervisor, the Building Manager, the C-AD ESH Coordinator or the ESHQ Division Head.

WASTE DISPOSAL

Improper disposal of radioactive or hazardous/industrial waste may result in fines, criminal prosecution, and facility shutdown.

- Contact the C-AD Environmental Coordinator for information on any waste.

- Contact the C-AD Environmental Compliance Representative (ECR) prior to establishing any new airborne, liquid, or solid radioactive or hazardous waste stream.

These individuals are familiar with rules, permits, authorizations and analysis requirements necessary for proper disposal.

Removing waste from the Laboratory is complex and costly. Your cooperation is necessary in order to control waste according to Federal, State, and Suffolk County regulations. Additionally, the regulations of States where waste from C-AD is ultimately disposed of must also be followed.

- Do not place clean materials in radioactive waste bins
- Do not place radioactive materials in the green 3-yard bins used for clean waste
- Substitute reusable materials where possible *
- Substitute environmentally friendly materials where possible
- Use minimum quantities of materials
- Segregate wastes
- Recycle whenever practical
- Do not leave unnecessary items in primary areas

* For example, we re-use radioactive lead whenever possible since it would become a "mixed waste" (hazardous and radioactive)

Each person is responsible to ensure that they handle, accumulate and dispose of waste using proper controls and documentation. All generators of hazardous or radioactive waste at C-AD must be specifically trained. Courses that could apply are:

Radioactive Waste Generator (HP-RADIGEN)
Hazardous Waste Generator (HP-RCRIGEN3)
Hazard Communication (HP-IND-200)

Hazardous waste is subject to time limits and volume limits that must be strictly adhered to. Generally, accumulation of more than 55 gallons at a satellite accumulation area is not allowed. Once the waste is moved to the C-AD Hazardous Waste Trailer, a 90-day clock starts. The waste must leave the C-AD complex within 90 days. Containers must be appropriate for the type of waste being collected and be dated and labeled. Your cooperation in this area is important in order to maintain C-AD's good reputation in the surrounding community.

Activated lead is an example of mixed waste. It is both hazardous and radioactive. Do not put mixed waste in radioactive waste cans. Do not mix liquids with dry radioactive waste. In addition to activated lead (Pb), another example of mixed waste is activated oil.

Do not throw clean metals into waste cans used for ordinary clean waste. Non-radioactive metals should be re-cycled. Metals in our clean waste stream are a problem since the Brookhaven Town Landfill will refuse BNL's clean waste if they find metal in it.

C-AD wishes to minimize radioactive waste in order to minimize cost and environmental impact. Ordinary clean waste such as packaging materials, coffee cups … etc should not be thrown into radioactive waste cans. This increases the radioactive waste disposal cost.

If you are ever unsure if the material you wish to throw away should be handled as hazardous or radioactive waste, THEN CONTACT THE APPROPRIATE INDIVIDUAL WHO CAN MAKE THE CORRECT DETERMINATION. Contacts include:

C-AD Environmental Coordinator
C-AD Environmental Compliance Representative

Question: You have to throw out empty cans of a liquid chemical that you used to clean equipment. You realize the liquid itself may require special handling but the containers are dry. What do you do?

Answer: Initially treat the container as hazardous waste and contact the C-AD Environmental Coordinator to learn the proper disposal procedure.

Question: You have sweepings from a building or area posted as a Radioactive Material Area. You normally place sweepings in the green 3-yard bins used for clean industrial waste and there is one nearby. What do you do?

Answer: Initially treat the sweepings as radioactive and contact Health Physics to have the sweepings checked prior to putting it in the green bins.

Radioactive waste WILL BE detected in either the green bins or the 50-yard garbage trucks and C-AD WILL INCUR significant expense to sort the waste and remove the radioactive material. Remember that saving a few minutes by not having it checked by a Radiological Control Technician (RCT) will cost C-AD many person-hours later, and could harm our reputation with stakeholders. Even low-level radioactive waste will be detected by the ultra-sensitive truck monitor. Do not assume that low level waste will be able to make its way unnoticed into the Brookhaven Town Landfill.

COMPRESSED GAS SAFETY

Note: Additional BNL training is required if you handle compressed gas cylinders

All compressed gases are hazardous due to high pressure. Compressed gases may also be hazardous because they are:

TOXIC: Gases that are poisonous in varying degrees ranging from extremely dangerous to life to only an irritant. Exposures to the more toxic gases can cause severe illness or death. Typical examples of harmful gases are Sulfur Hexafluoride, Carbon Monoxide, and Hydrogen Sulfide.

FLAMMABLE: A condition that results when even small quantities of a specific gas when mixed with air forms a mixture that is capable of being ignited. Once ignited, the burning gas mixture can ignite other nearby combustible materials. Typical flammable gases are Acetylene, Hydrogen, and Methane.

CORROSIVE: Corrosive materials can cause visible destruction or irreversible injury to human skin and eyes (similar to a burn) at the site of contact or can cause serious degradation of various construction materials, such as steel, or brass. An example of a corrosive gas is Chlorine.

OXIDIZERS: A gas that supports or enhances combustion. These gases must be handled with caution since they increase the potential for fire or explosion. They require special storage considerations. Typical oxidizer gases are Oxygen, Chlorine, Fluorine, and Nitrogen Oxides.

ASHYXIANT (oxygen displacement): Asphyxiation is a condition which results when a gas reduces the concentration of breathable oxygen to a hazardous level in air by displacing and diluting normal air. Typically all gases other than oxygen and air can do this. Examples are Sulfur Hexafluride, Helium, Nitrogen and Carbon Dioxide.

Cylinder Receipt and Content Identification

Because of the different hazards associated with different gases, it is important that cylinders be properly labeled. When a cylinder is delivered to the BNL gas warehouse, a laboratory area or a job site, it should have:

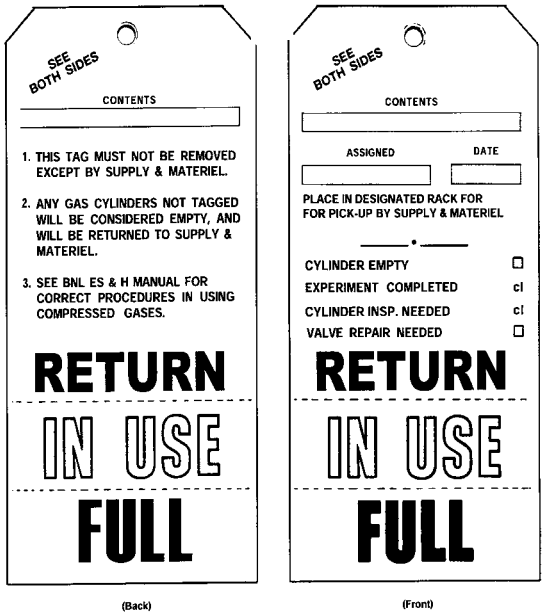
- **content identification**,
- **DOT label**, and
- **a valve protection cap**.

UNDER NO CIRCUMSTANCE should the means of identification be removed from a cylinder. The valve protection cap should remain in place until the user has secured the cylinder to a fixed support at the point of use and is ready to attach a pressure regulator to withdraw the contents.

Sometimes cylinders are received with no identification other than a color code. There is no uniformity in the identification of cylinder contents through color coding of the cylinders. **Under no circumstances should such cylinders be accepted.**

DOT labels have a minimum of precautionary handling information and will classify the cylinder contents.

The personnel at the BNL gas warehouse will attach a Cylinder Status Tag on the cylinder when it is delivered. Tear off the bottom of the Cylinder Status Tag and write the name of the assigned user on the tag indicating the cylinder is in use.



General Rules for Cylinder Handling

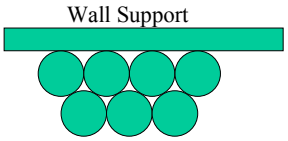
- Do not drop cylinders or permit them to violently strike each other.
- Do not roll cylinders in a horizontal position.
- Do not drag cylinders.
- Do not handle cylinders with oily hands or oily gloves. This is especially important when handling oxygen and other oxidizers.
- If hoisting is necessary, use a suitable cradle or platform.
- Do not lift a cylinder by its cap.
- Keep cylinder caps on the cylinder whenever they are not in use.
- Transport cylinders using a cart or hand truck designed for that purpose, securing the cylinders.
- Whenever placing a cylinder in service, check the hydrostatic test date. If a cylinder is not in service it must have a hydrostatic test performed every five years.

Compressed Gas Cylinder Safe Storage

- Storage areas should be dry, cool, and well ventilated, and where practical, fire resistant.
- Gases of different types are to be grouped by type and non-compatible types should be separated. Flammable gases shall not be stored with oxidizing gases.
- Cylinder storage areas are to be prominently posted with the types of gases stored.
- Charged and empty cylinders should be stored separately.
- Cylinders should be arranged so that old stock can be removed first with minimum handling of other cylinders.
- Cylinders should not be stored at temperatures above 125 ^{0}F, (51 C) or near sources of heat.
- Cylinders should not be stored near highly flammable or combustible materials.
- When cylinders are being moved on a cylinder cart, pallet, or truck, they must be secured.

Safe methods for securing capped compressed gas cylinders in storage include the three-point contact system. This is done by restraining cylinders in a tight mass using a contiguous three-point system with other cylinders or solid support structure. All compressed gas cylinders shall be secured to prevent falling. An appropriate method for securing cylinders is by providing a substantial chain, which is positioned in front of, or around the cylinder(s), and secured to a solid structure.

Three Point Contact System



All cylinders are in contact on three points either with other cylinders or the wall

Note: A chain would also be used.

FIRE OR OTHER EMERGENCY

Upon entering any building or experimental area at the C-AD complex one should note the locations of emergency equipment as well as the exit points.

Make a mental note of the following that may be in your work area:

- Exits
- Fire Alarm Pull Boxes
- Intercoms / Telephones
- TLD Requirements
- Conventional Safety Hazards/Postings
- Radiological Safety Hazards/Postings
- Safety Equipment
- Emergency exhaust
- Assembly Areas
- Plectrons (radio controlled electronic alerting devices)

If there is a fire or other emergency such as an injury or illness, pull a fire alarm pull-box if one is in the area and telephone the Fire/Rescue Group: 911 or x2222. It does not have to be a fire to pull the fire alarm pull-box. You may use the fire alarm in a medical emergency - also still call 911 or x2222 however.

From a cellular phone, dial 344-2222. If not a "631" area code cell phone, then dial 631-344-2222.

Fire alarm boxes are located throughout the accelerators, at the entrances to target caves, experimental halls, and the Collider tunnel. They are the best method to simultaneously alert MCR and the BNL Fire/Rescue Group. Pulling a fire alarm box brings the Fire/Rescue Group to your specific alarm-box location within about two minutes, and appropriate additional personnel can be summoned quickly.

Accelerator rings/tunnels and target rooms are restrictive spaces. If fire should break out, then smoke could quickly impair visibility, and asphyxiation from smoke is a possibility. If fire breaks out, then get out immediately. There are escape hatches in the accelerator rings. Emergency exit signs will point you to the nearest exit. Next to the escape hatches in the accelerator rings is an emergency exhaust button that when activated will pull the smoke away from the hatch.

At the Collider Tunnel, vertical and horizontal emergency exits alternate and are located throughout the tunnel. At the intersection regions there are multiple horizontal exits. All exits go to the inner ring road.

Once outside a smoky area, obey the directions of the Fire Captain, or of the Local Emergency Coordinator (LEC) or Department Emergency Coordinator (DEC) if they are present. They will be wearing baseball-like caps marked DEC or LEC. Do not chat with the Fire Captain or other emergency response personnel in the area. Personnel are to assemble at least fifty feet from the building or at a designated outside assembly area.

If you hear a Fire Alarm Bell, evacuate the area after placing equipment in a safe operating mode. C-AD Main Control Room (MCR) Personnel or other shift personnel will remain on station if they have emergency duties, but will evacuate during imminent danger situations.

Summary of Alarm Signals

Orange Strobe and Audible Alarm

OR

Lights go dim or go out and Audible Announcement : *Beam is Imminent*
Pull crash cord or push crash button or exit through ("crash" through) the Primary Area access gate, exit the area, contact MCR.

Blue Strobe and Audible Alarm: *Oxygen Deficiency Event*
For Helium, exit the area through horizontal exit, stay low.
For sulfur hexafluoride (at the Tandem) leave low laying areas.

Move away from any vapor cloud or "wooshing" noise.

Yellow Strobe and Audible Alarm (two-tone horn)**:** *Combustible/explosive or Flammable Gas Leak*
Exit the area, report to outdoor assembly area

Fire Alarm Bell (the typical metal "clanging" bell sound)**:** *Fire*
Exit the area, report to outdoor assembly area

DO NOT RENTER buildings. Wait for further instructions from the Fire Captain, Local Emergency Coordinator (LEC), Department Emergency Coordinator (DEC) or the C-AD ESH Coordinator.

Indoor and Outdoor Assembly Areas are posted at building entrances.

ACTIONS FOLLOWING AN INJURY/ILLNESS

If there is a medical emergency involving an injury or an illness such as a heart attack or other illness or injury for which immediate medical attention is wanted, then pull a fire alarm box (if one is in the area) and call x2222 or x911. From a cell phone, dial (631) 344-2222.

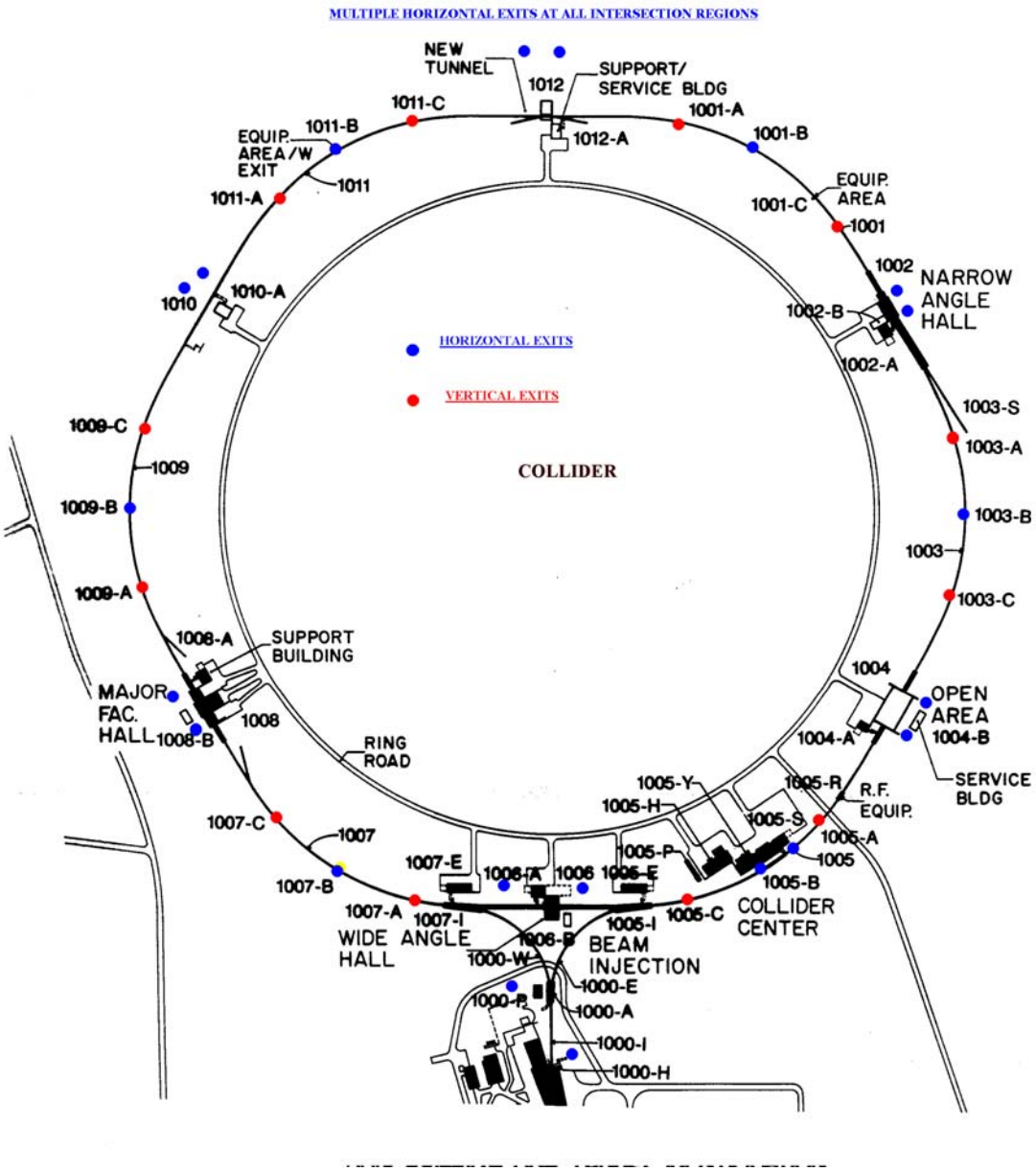
Unless an injury is very minor:

Never transport the injured person to the Clinic yourself, wait for the Fire Department to arrive with the EMT and ambulance. Make sure you pull the Fire Alarm box to immediately let Fire/Rescue know of the location of the problem. Follow up immediately with a call to 2222 or 911 or on a cell 344-2222 to let F/R know it is an injury so the EMT/ambulance are dispatched to the scene (they usually don't send the ambulance for a fire only).

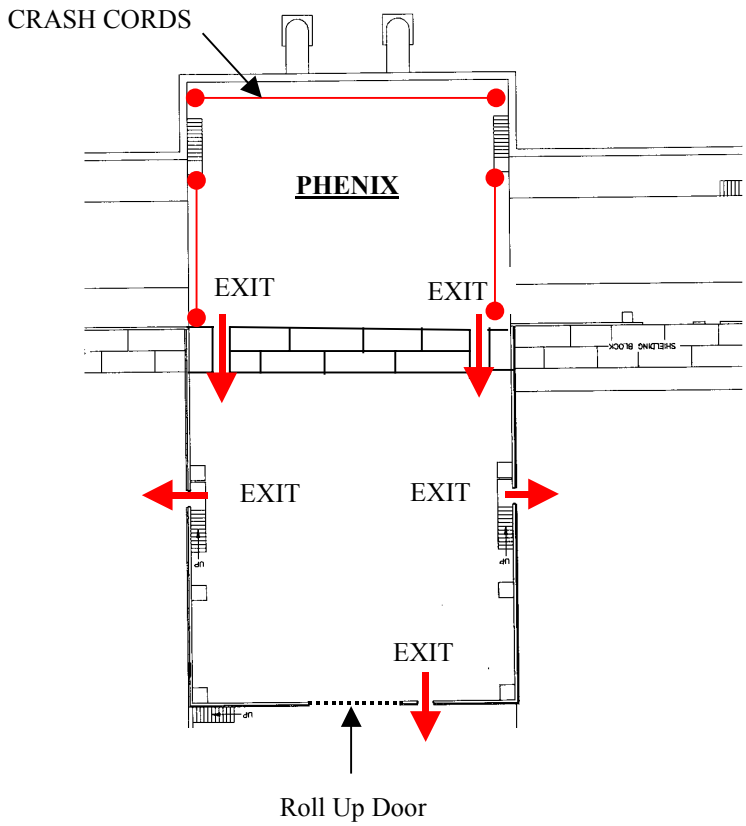
If you transport the person yourself, time may be wasted in having the ambulance track you down. In addition, you may be stuck with an injured person who passes out or stops breathing, etc., on the way to the Clinic or you could be nervous and have an accident on the way to the Clinic.

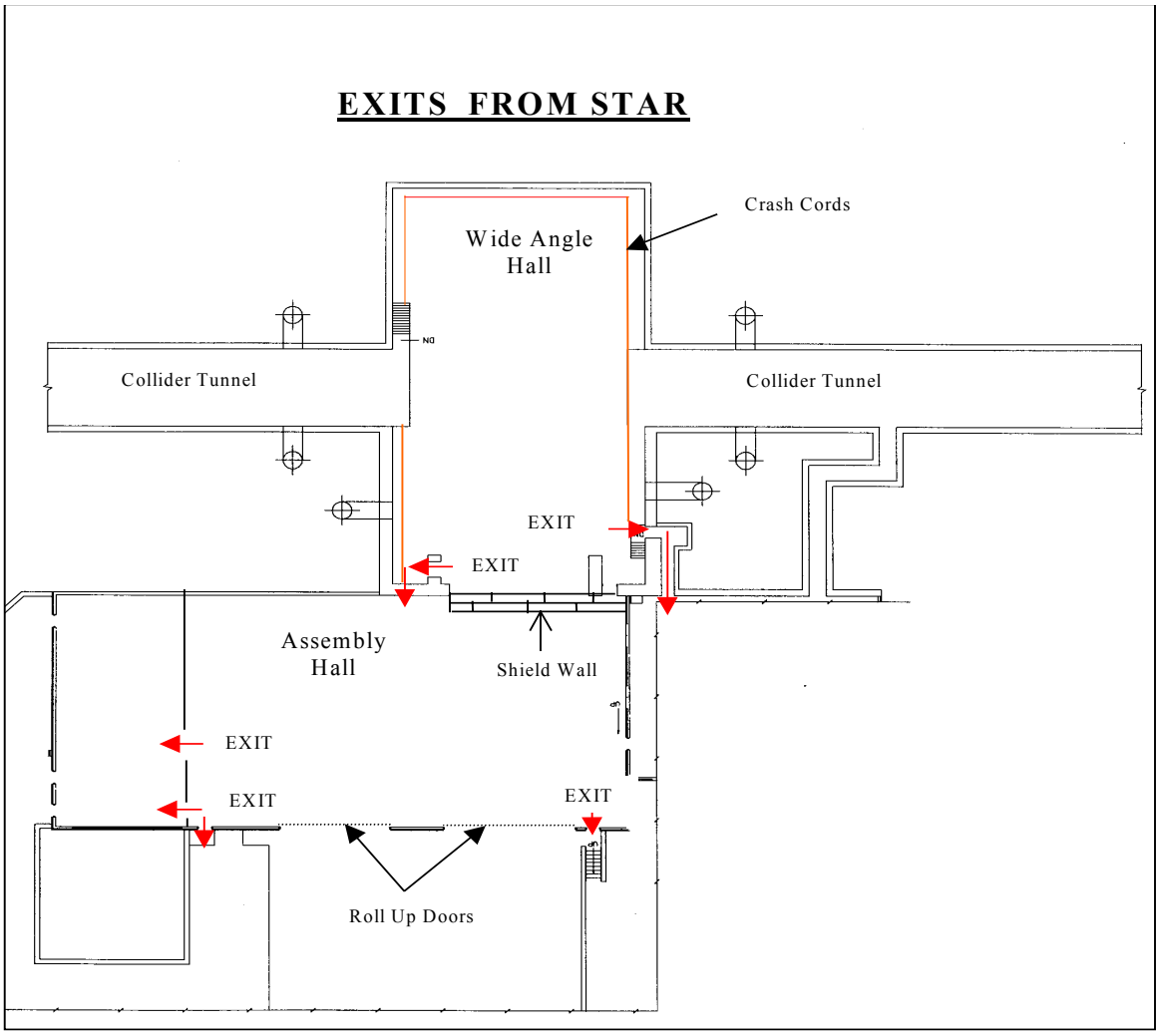
If you are injured but do not require emergency attention, then report as soon as possible to the BNL Occupational Medicine Clinic (OMC), which is located in Building 490. Your supervisor should accompany you. If your supervisor is not available, you should call upon another member of supervision or management in your Department, Division or work area to go with you. In most circumstances, it is expected that you report to the Clinic immediately after the injury. If this is not possible, you are required to notify the Clinic immediately and report to the Clinic with your supervisor, or alternate member of management, before the end of the work shift in which the injury occurred, or at the start of your next work-shift. If employees fail to notify and report to the Clinic as required, any resulting missed work may be considered unauthorized leave and will be ineligible for sick leave.

EXITS FROM COLLIDER TUNNEL AREAS

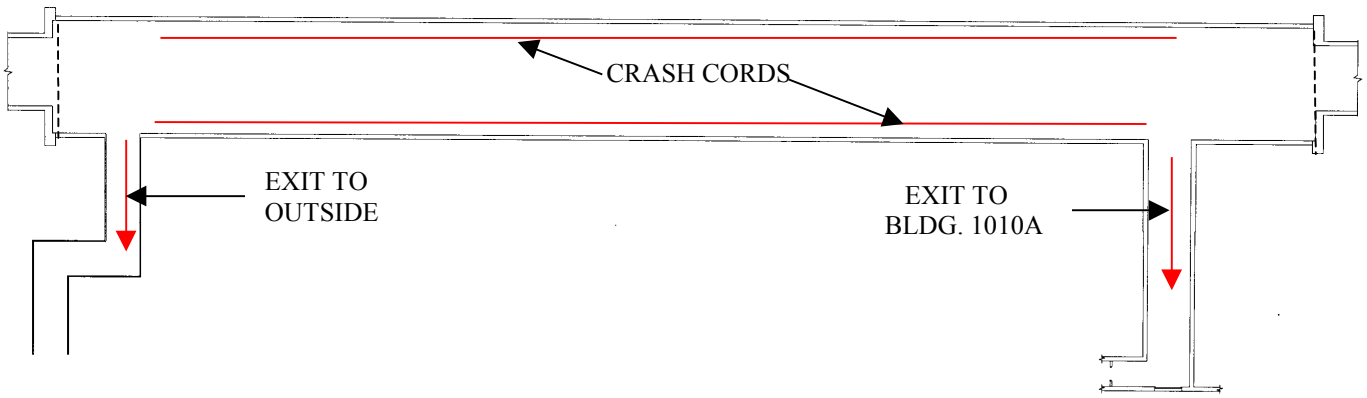


EXITS FROM PHENIX

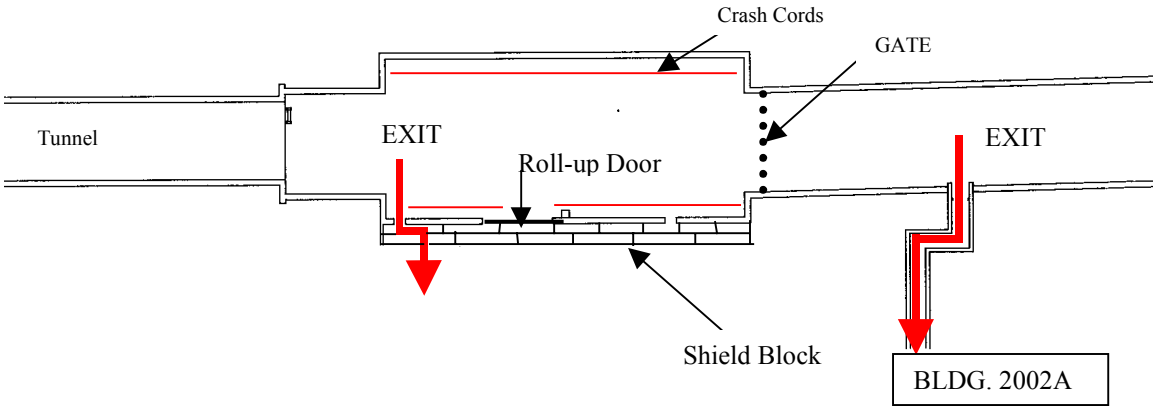



EXITS FROM STAR
Crash Cords
Wide Angle Hall
Collider Tunnel
Collider Tunnel
EXIT
EXIT
Assembly Hall
Shield Wall
EXIT
EXIT
EXIT
Roll Up Doors

EXITS FROM PHOBOS



EXITS FROM BRAHMS



List of Acronyms

AGS	Alternating Gradient Synchrotron
ALARA	As Low As Reasonably Achievable
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
C-AD	Collider Accelerator Department
DEC	Department Emergency Coordinator
DOE	United States Department of Energy
ESHQ	Environment, Safety, Health & Quality
FEB	Fast Extracted Beam
FS	Facility Support
HP	Health Physics
IR	Intersecting Region
I&SM Group	BNL Isotopes & Special Materials Group
LEC	Local Emergency Coordinator
LOTO	LockOut/TagOut
MCR	Main Control Room
NFPA	National Fire Protection Agency
NSRL	NASA Space Radiation Lab
OC	Operations Coordinator
ODH	Oxygen Deficiency Hazard
OJT	On-the-Job-Training
OSHA	United States Occupational Safety and Health Administration
PAAA	Price-Anderson Amendments Act
RCD	BNL Radiological Control Division
RCT	Radiological Control Technician
RWP	Radiation Work Permit
SEB	Slow Extracted Beam
SRD	Self Reading Dosimeter
TLD	Thermo luminescent Dosimeter

Contacts:

	BNL extension	
C-AD Training Manager	7343	digital pager 4210
C-AD ESHQ Division Head	5272	digital pager 4820
C-AD ESH Coordinator	7200 or 4006	text pager 631/453-5940
C-AD Main Control Room (MCR)	4662	
C-AD Work Control Manager	5636	
C-AD Health Physics Group	4660	
C-AD FS Rep (also called RCD Rep)	5992	
BNL I&SM Group	4051	
C-AD Source Custodian	5636	
C-AD Maintenance Coordinator	7205	
C-AD Associate Chair for ESHQ	4250	
C-AD Environmental Coordinator	7520	text pager 631/453-5905
C-AD Environmental Compliance Rep	2905	
C-AD Radioactive Source Custodian	5636	